ROYAL ASTRONOMICAL SOCIETY.

VOL. XIII. *Feb.* 11, 1852. No. 4.

THE Annual General Meeting of the Society, J. C. ADAMS, Esq., President, in the chair.

Rev. J. V. Mummery, Richmond Grove, Canonbury;
Rev. W. Giles, Chester; and
Rev. Josh. Woolley, LL.D., H.M. Dockyard, Portsmouth;
were balloted for and duly elected Fellows of the Society.

Report of the Council to the Thirty-third Annual General Meeting.

The Council meet the Society again with pleasure, in the accounts they are able to give of the past year and of the prospects of astronomy for the future. With the exception only of those parts of their Annual Report which must always be brought forward with regret, the obituary record, and notice of retirements, or other loss of services, there is nothing on which they may not dwell with satisfaction. But the Society has now attained an age which, in the course of nature, makes it necessary to record the deaths of its oldest members more frequently than hitherto, and the present Report must be marked by its notice of the loss of General Colby, one of our oldest Fellows and most familiar names.

The Report of the Auditors, subjoined, will show the state of the finances:—

RECEIPTS.

	£	s.	d.
Balance of last year's account	276	0	11
By dividend on £2512 14*s.* 11*d.* 3¼ per Cents	39	12	10
By ditto on £1150 Consols	16	15	0
By ditto on £2575 18*s.* 9*d.* 3¼ per Cents	40	12	9
By ditto on £1150 Consols	16	15	0
On account of arrears of contributions	119	14	0
116 contributions (1852–53)	243	12	0
4 ditto (1853–54)	8	8	0
5 compositions	105	0	0
14 admission fees	29	8	0
9 first year's contributions	14	14	0
Sale of Publications	63	9	6
	£974	2	0

EXPENDITURE.

	£	s.	d.
Cash paid for investment of compositions of Rev. T. W. Webb, H. L. Pattinson, Esq., and Rev. T. A. Southwood	63	0	0
Mr. Basire, engraver	19	19	0
Mr. Wyon (medals)	57	15	0
George Barclay (printer)	127	1	1
Taxes { 1 year's income tax ..... 1 9 2 / 1 year's land tax 4 15 10	6	5	0
J. Williams, for sundry disbursements, as per accounts Nos. 1, 2, 3, 4	99	15	10
Ditto for salary	100	0	0
Ditto commission on collecting £479 5*s.* 6*d.*	23	19	6
Balance in Treasurer's hands	476	6	7
	£974	2	0

Assets and present property of the Society:—

	£	s.	d.
Balance in the hands of the Treasurer	476	6	7
Due from Mr. Byng £24 8 0			
2 contributions of 7 years' standing 29 8 0			
4 ——— of 5 ditto 33 12 0			
2 ——— of 4 ditto 16 16 0			
5 ——— of 3 ditto 31 10 0			
6 ——— of 2 ditto 25 4 0			
17 ——— of 1 ditto 35 14 0			
	196	12	0
Due for publications of the Society	3	6	0

£1150 3 per Cent Consols.
£2575 18*s.* 9*d.* 3½ per Cent Annuities.
Unsold publications of the Society.
Various astronomical instruments, books, prints, &c.

Stock of volumes of the *Memoirs*:—

Vol.	Total.	Vol.	Total.	Vol.	Total.
I. Part 1	40	VII.	223	XVII.	253
I. Part 2	83	VIII.	210	XVIII.	270
II. Part 1	102	IX.	218	XIX.	289
II. Part 2	63	X.	228	XX.	304
III. Part 1	130	XI.	238		
III. Part 2	150	XII.	247		
IV. Part 1	152	XIII.	264		
IV. Part 2	165	XIV.	451		
V.	180	XV.	277		
VI.	198	XVI.	263		

Progress and present state of the Society:—

	Compounders.	Annual Contributors.	Non-residents.	Patroness. and Honorary.	Total Fellows.	Associates.	Grand Total.
February 1852	134	178	65	6	383	58	441
Since elected	3	11	...	...	14	...	14
Deceased	—6	—3	—1	...	—10	...	—10
Removals	2	—2	...	...	...	...	...
February 1853	133	184	64	6	387	58	445

The instruments belonging to the Society are now distributed as follows:—

The *Harrison* clock,
The *Owen* portable circle,
The *Owen* portable quadruple sextant,
The *Beaufoy* circle,
The *Herschelian* 7-foot reflector,
The *Greig* universal instrument,
The *Smeaton* equatoreal,
The *Cavendish* apparatus,
The 7-foot Gregorian telescope (late Mr. Shearman's),
The Universal quadrant by Abraham Sharp,
The *Fuller* theodolite,

are in the apartments of the Society.

The Brass quadrant, said to have been *Lacaille's*,

is in the apartments of the Royal Society.

The Standard scale

is in the charge of the Astronomer Royal, with the consent of the Council, to be employed in the construction of a new Standard Measure, under the direction of the Standard Committee.

The remaining instruments are lent, during the pleasure of the Council, to the several parties undermentioned, viz.:

The *Beaufoy* clock,
The two invariable pendulums, } to the Royal Society.
The *Wollaston* telescope, to the representatives of the late Professor Schumacher.
The other *Beaufoy* clock, to Dr. Drew.
The *Lee* circle, to Captain Blackwood.
The Variation transit (late Mr. Shearman's), to Mr. Gravatt.

The 1st Part of the 4to. Memoirs for 1851–2, vol. xxi. was published a few weeks ago. It contains all the observations of the total eclipse of July 28, 1851, which have been communicated to the Society. The long delay has been occasioned by different circumstances, which need not be specified here. We believe the volume is a tolerably complete record of what was seen by the English observers, and it is got up on a uniform plan. The illustrative engravings are confined, rather strictly, to the purely astronomical phenomena, and have no pretension beyond that of rendering the sketches of the observers. Notwithstanding the precautions previously taken to methodize the observations of this eclipse, the astonishment of the observers seems pretty generally to have deprived them of the power of noting every thing which might have been done, if the phenomenon had been more familiar. Still we conceive that the observations contained in our volume will be considered a very valuable contribution to this very interesting and mysterious subject.

The second part of vol. xxi. is now in type, except the reprint of the Annual Report.* It contains four Memoirs by Mr. Maclear, viz. a continuation of his Examination of the Southern Stars of the B.A. Catalogue; a careful series of Observations of Petersen's Comet with the new $8\frac{1}{2}$-feet equatoreal; an Investigation into the Parallax of β *Centauri*, the existence of which seems highly probable; and Observations with the Mural Circle of *Mars* near his opposition. The Lords of the Admiralty, on the application of the Astronomer Royal, have, with their usual liberality, consented to defray the expense of publication. A paper by Mr. Dawes on an improvement in the eye-piece, by which solar spots and many other phenomena can be more accurately observed, with a reprint of the Annual Report, and a revised list of Fellows, will complete the 4to. half-volume.

The 8vo. half-volume, corresponding to vol. xxi. has been published some time. This is *presented* to the purchasers of the 4to. volume, and is absolutely necessary to complete the transactions of the Society for the year.

In the present Session a considerable change has been made in the *Monthly Notices*, to which your attention is particularly requested.

It is not in the power of the present Editor to continue his services longer, as the motives which occasioned his frequent visits to London no longer exist. It would not be possible for a non-resident to discharge the duties satisfactorily, and it is, besides, Mr. Sheepshanks's intention to spend the next winter abroad. In the opinion of the Council it is not to be expected that the labour of superintending the publications of the Society should in future be discharged gratuitously, as the work is too heavy, too continuous, and too responsible, to be imposed upon gentlemen who are most of them far too severely tasked by business of their own. In this

* This part is published since the date of the Report.

emergency the Council have been fortunate enough to find in Mr. Grant, now so well known to you by his history of *Physical Astronomy*, a gentleman able and willing to undertake the editorship of your publications, for a sum which your finances will very well allow. It is, indeed, only as a labour of love, that the moderate salary proposed, 40*l.* a-year, can be considered a compensation.

The present time, therefore, seemed a good opportunity for reconsidering the composition of the *Monthly Notices*, and for adopting such alterations and improvements as experience and the very peculiar qualifications of the new Editor suggested.

In the *Notices*, as they have existed for the last few years, an attentive reader would probably be struck by the large amount of expensive printing which has been devoted to series of planetary and cometary observations, and to ephemerides. This has been in a great measure useless, as *all the observations and all the ephemerides* appear *earlier* in the *Astronomische Nachrichten*, a publication which must be in the hands of every one who pays serious attention to planetary and cometary observations.* It is not desirable to print in duplicate what is elsewhere printed as well, or to have two sources for the same information. In the *Astronomische Nachrichten*, not only the English, but all the trustworthy observations will be found which are made in every part of the globe; and the computer or analyst should not be distracted by having any other incomplete authority to refer to. This seems, too, more accordant with the nature of the science, which is essentially the same for all civilized nations, and may to a great extent be most beneficially served by a common organ.

It is not, however, intended to keep out all observations, but only those which can have no interest except to persons who, having the special object of computing planetary or cometary orbits, must of necessity have recourse to the *Astronomische Nachrichten*.

With respect to the ephemerides of recently-discovered planets, if they are computed in this country, an exception might be made in their favour, as some time would be thereby gained; those computed abroad are generally received as early through the *Nachrichten* as is practicable, far earlier than by the *Monthly Notices*.

The ephemerides of planets of a year's standing might, with a little arrangement, always appear in the *Nachrichten*, and those of planets of a still longer date would certainly be computed either by Professor Encke or Lieutenant Stratford, if the work were divided, or if it were settled by whom it should be done.

A hasty computation shows that the expense thus saved in the *Monthly Notices* will very nearly pay for the editorship, on the moderate scale which is contemplated. But it is not intended to limit the change to mere reduction; on the contrary, it is intended to fill up the space thus gained, and probably more, with interesting,

* It is a fact, that the *Ast. Nach. is* taken in by *all* the observers who have contributed planetary and cometary observations to the *Monthly Notices*, and that all the observations and ephemerides which are found in the *Monthly Notices* are also found in the *Ast. Nach.*, to which they are regularly sent.

but strictly scientific astronomical information. In other respects no change is intended.

First, it is proposed to insert notices and abstracts of valuable astronomical papers contained in the *Astronomische Nachrichten*, the *Comptes Rendus*, and other periodicals, including the Memoirs of different Societies at home and abroad.

Secondly, to give the accurate titles of new books of value and interest which have been presented to the Society, or which can be carefully examined. When practicable, such an account will be given of these works as may enable any one to form an opinion whether they are likely to suit him, and frequently this may be done in a few words.

Thirdly, but this must depend upon the co-operation of the Fellows, notices will be given of older works, which, from their importance and rarity, deserve or require particular attention.

Notwithstanding the zeal and extraordinary qualifications of Mr. Grant, it is scarcely possible that all these objects should be satisfied, unless the members of the Society will assist a little, each in his own walk; but with this help it may reasonably be expected that the *Monthly Notices* will fill up a void which is felt by the astronomers of England, and probably by those of most other countries, while they will avoid any unseemly rivalry with other publications.

The Council cannot lose the services of Mr. Sheepshanks, though they trust the loss will only be temporary, without expressing their sense of the very great benefit the Society has derived from them, both as Editor of the *Monthly Notices* and as an active member of the Council. The change in the *Monthly Notices*, from no more than a record of what passed at the ordinary meetings, into a publication of the character of transactions, but of much more frequent appearance, and more rapid in its announcements, is entirely due to him. And though the Council feel that the residence of so energetic a member abroad will materially tend to increase the connexion of the Society with the part of Europe in which he resides, to the advantage of astronomy both here and there, yet they do not accept this benefit as an adequate compensation for the loss of services which, always of value, were of the utmost importance since the greatest crisis of the Society's affairs — that caused by the death of Mr. Baily.

It may seem useless, after what has just been said, to call particular attention to the *Astronomische Nachrichten*, but the importance of that publication to the progress of our science can scarcely be estimated too highly, or too often insisted upon. Besides researches of the highest value by the most eminent geometers of the Continent, the amateur astronomer will find a most complete collection of observations and ephemerides, and other information which he may require. These are quite intelligible to a person not acquainted with German, even when that language is used; but an Englishman will find a good deal in his own tongue, either of English or American produce, and may not be displeased to learn that the

honour of his race is so well supported. The subscription is so reasonable and so easily paid, and the work itself is of such vital importance, that it may be safely recommended to the support of lovers of science generally, upon that account alone. But every one who is either an observer or computer will find a sufficient motive in the work itself, and in his own gratification and instruction. The *Nachrichten* and *Monthly Notices* combined should find an intelligent amateur a good deal to do, and a good deal to think upon, and jointly they would keep him pretty well up with the advance of the science.

It may be well to remind gentlemen who have imperfect copies of this work, that no time should be lost in giving notice of their wants. A list will be sent very shortly to Altona of these lacunæ; and it will be difficult, if this opportunity be neglected, to supply them hereafter.

The Council have awarded the gold medal to Mr. J. R. Hind, for his astronomical discoveries, and in particular for the discovery of eight small planets. It is true that, at the time when the proposition to award this medal was first entered on the minutes of the Council, the number of planets discovered was but six; nevertheless, looking at the circumstance that the merit of this discovery lies in the skill and perseverance with which the systematic examination of the heavens was made, the Council feel justified in making the terms of the announcement contain the number of proofs of success extant at the time when the final award was made. The President will detail the grounds of the award at the close of the meeting.

The Council have to regret the loss, by death, of the following Fellows: — W. T. Clark, Esq.; Major-general Sir T. Colby; S. E. Cottam, Esq.; Geo. Dollond, Esq.; Rev. J. Edmonstone; Thos. Jones, Esq.; Lieut. Lecount; T. Norris, Esq.; Rev. Chas. Turnor; and J. Vandercom, Esq.

William Tierney Clark, Esq. was born on the 23d of August, 1783, at Sion House, in Somersetshire. He commenced his career under a millwright at Bristol, to whom he was apprenticed when very young for several years. From Bristol he went to Coalbrook Dale, where he continued till the year 1808, when he went to London, and was shortly after, at the request of his former employers, admitted as a draftsman into the employment of the late Mr. Rennie, with whom he remained till 1811, when he was appointed engineer of the West Middlesex Waterworks. At that period the West Middlesex Waterworks were in a comparatively insignificant state. They had been established upon a very limited scale, and the greatest capabilities of the works were confined to supplying water to the neighbouring hamlets by means of a small pumping-engine of twenty horse power, and a small reservoir, barely sufficient to contain a day's supply. The West Middlesex

Waterworks had only been established in 1806; they were then unremunerative, nor did they yield any dividend until several years after Mr. Clark became manager of them. Mr. Clark, however, was not disheartened: on the contrary, he encouraged his employers to make new sacrifices, by increasing the amount of their capital and expending it judiciously in increasing the works. He foresaw the prosperity which would ere long attend those sacrifices, and he spared no exertion to render the works as perfect as possible, by increasing the number and power of the engines and the capacity of the reservoirs; so that, from the insignificant establishment of 1819, based upon a capital of 20,000*l.*, producing no revenue, he left the works at his death increased to three large pumping-engines of the aggregate power of 245 horses; two capacious reservoirs, capable of containing between thirty-five and forty millions of gallons, and of supplying an abundant quantity of good water to the extent of one-tenth of the whole supply of the metropolis, with a capital of nearly 700,000*l.*, and an annual rental of nearly 70,000*l.* per annum. Such was, in a great measure, the result of Mr. Clark's labours.

The first work of civil engineering undertaken by Mr. Clark was the Thames and Medway Canal. That work had been commenced by a company of shareholders, for the purpose of profiting by the advantages which they expected to derive from shortening the navigation between Gravesend and Chatham forty miles, by means of a cut across the isthmus which separates the Thames and the Medway. The project had been stopped for want of capital, but it was again resumed under Mr. Clark's direction in 1819, but was not completed till several years afterwards. The canal was principally remarkable from the great length and size of the tunnel, and which, in carrying through the Frinsbury ridge of hills near the Medway, occasioned great difficulty and expense. This canal is now converted into a railway.

Mr. Clark's next work was the Hammersmith Suspension Bridge. It was commenced in 1824, and finished in 1827. Its dimensions have been described elsewhere; suffice it to say, that it is principally remarkable for the small deflexion of the chains between the chord line or points of suspension, being 422·3, the versed sine is only 29·6 or $\frac{1}{14}$.

The Marlow Suspension Bridge over the Thames was originally designed and commenced by his predecessor in the West Middlesex Waterworks, Mr. Millington, in 1829, but was completed after Mr. Clark's own design. The bridge resembles in its style and construction that of Hammersmith, with slight difference in the dimensions and in the architecture of the piers and suspending towers.

The same may be said of the Norfolk Suspension Bridge, which he erected for the Duke of Norfolk, near Shoreham, over the Arun. The style of architecture is more decorative and elegant.

Mr. Clark erected about this period a handsome cast-iron bridge at Bath, also a small cast-iron bridge at Windsor.

But the finest work of Mr. Clark is the Pesth Suspension Bridge over the Danube. The origin and progress of this magnificent undertaking will be found in an octavo volume recently published by Mr. Weale, under Mr. Clark's directions. It contains a translation of the Reports of Counts George Andrassy and Stephen Széchenyi on the expediency of constructing a bridge over the Danube between the cities of Pesth and Buda; their questions to and answers from Mr. Clark; the memoir of Count Széchenyi; a Report of the Ban Direction, or Board of Bridges and Roads; and a detailed statement by Mr. Clark himself of the progress of the works of the bridge, from their commencement in 1839 to their completion in 1849: from which it appears that the total cost of the bridge, without deducting the old materials, was 622,042*l.*

In 1845 Mr. Clark sent over to St. Petersburg a magnificent design for a suspension bridge over the Neva. It was greatly admired by the Emperor, who in return presented him with a first-class gold medal.

The Emperor of Austria also presented Mr. Clark, through the Archduke Charles, with a splendid box set in brilliants, as a token of his approbation on the completion of the Pesth Suspension Bridge.

"Thus," says Mr. Clark, "was finished Pesth Suspension Bridge, a work which in its construction encountered probably more difficulties than any structure of a similar kind in existence. The magnitude of the river over which it is thrown, the depth and nature of its bed, and velocity of the current, created the misgivings, at one time almost universal in Hungary, that no permanent communication could ever be established across the Danube between Buda and Pesth. The moral difficulties to be overcome, no less than the physical obstacles, were very great. Pride, prejudice, and jealousy, had each to be encountered; so universal against the object at one period, that nothing less than the extraordinary energy and perseverance shown by Count Széchenyi could have withstood their evil effects, and few would have made the attempt."

Our limits preclude our entering into the difficulties which the bridge encountered from the bursting of the dams, the shocks of the ice, or the ravages of hostile armies. The physical difficulties were all encountered and overcome by the energy and perseverance of Mr. Clark and his assistants. The Suspension Bridge of Pesth while it stands, a monument to his genius, is the admiration of all who have seen it. It was the last and crowning act of a life devoted to a profession of which he was an ornament. He died on the 22d of September last, aged sixty-nine, deeply regretted by all who were intimate with him. His remains were consigned to a family vault in Hammersmith church.

Thomas Colby, born at Rochester on the 1st September, 1784, was a son of Major Colby of the Royal Marines, who served during the war, and was in several engagements under Lord Howe and other naval commanders; he had four uncles in

the army, one of whom, General Hadden, was Surveyor-general of the Ordnance, and another, Colonel Hadden of the 11th Regiment, was Paymaster-general of the Forces in Portugal. Thomas Colby was educated at Northfleet, Kent, by the late Dr. Crackell, a man fully capable of appreciating the superior abilities of his pupil; from this school he proceeded to the Royal Military Academy at Woolwich, and after having been selected for, and appointed to, the corps of Royal Engineers, was placed under Mr. Robert Dawson, of the corps of Royal Military Surveyors and Draftsmen, then employed on the Ordnance Survey of Cornwall, for the purpose of being instructed in surveying and military drawing. At this time he met with an accident, by the bursting of a pistol, which deprived him of his left hand, and very nearly cost him his life, as a part of the barrel entered his head. This accident had an important bearing on his future career: the loss of the hand was a serious hindrance and objection to military service, but Major Mudge, the Superintendent of the Trigonometrical Survey, knowing Lieut. Colby's qualifications, with great kindness and consideration applied immediately to the Master-general of the Ordnance, that he might be permanently attached to the survey as an assistant to himself, in the same way that he had formerly been to his predecessor, Lieut.-colonel Williams, R.A.

Having been appointed second lieutenant on the 21st December, 1801, when a little more than seventeen years of age, and posted to the survey in January 1802, he was for many years employed during the summer and autumn months in observing at various stations with the great theodolite and zenith sector (both constructed by Ramsden), for the principal triangulation and the measurement of the arc of meridian between the Shetland Isles and Isle of Wight; and during the rest of the year was engaged at the Drawing-room in the Tower of London, in roughly computing the results of the summer's observations and preparing them for publication, and in superintending the construction and engraving of the Ordnance Maps of England and Wales, on the scale of one inch to a mile, or $\frac{1}{63360}$: meanwhile, he was made a first-lieutenant in August 1802, and captain in July 1807.

He assisted, and was associated with, Lieut.-colonel Mudge, in preparing the third volume of *An Account of the Trigonometrical Survey of England*, which was published in 1811; and on Major-general Mudge's death, in 1820, he was appointed by his Grace the Duke of Wellington to succeed him as Superintendent of the Trigonometrical Survey, having been strongly recommended by the President of the Royal Society, Sir Joseph Banks, to whom the Duke referred for his opinion of Captain Colby's scientific qualifications for the appointment.

He obtained his majority by brevet in July 1821, and in this and the two following years we find him associated with Captain Kater, appointed by the Royal Society to co-operate with MM. Arago and Mathieu, acting in behalf of the Institute of France, in the verification of the connexion between the observatories of

Greenwich and Paris; the English portion of the triangulation for this purpose had been originally executed by Major-general Ross, and was now revised by Captain Kater and Major Colby, who both personally assisted in making the observations; and Major Colby afforded the aid of Mr. James Gardner, one of the most experienced observers on the survey.

In 1824 the survey of Ireland was commenced, after a careful investigation before a select committee of the House of Commons as to the best method of proceeding with such survey, its nature, scale, and the details it should embrace; and on the recommendation of that committee its execution was entrusted to the Ordnance Department, and confided by the Master-general of the Ordnance, the Duke of Wellington, to Major Colby's charge. This survey being intended to facilitate a general valuation of property throughout Ireland, with a view to apportioning more equally the local taxation, was required to be so precise that the accuracy of its details should be unquestioned; on the other hand, the cost of the survey was to be kept within reasonable limits.

Major Colby, therefore, wisely determined not to adopt the system of working by contract, then followed in England, in the preparation of the Ordnance Map of England and Wales, but to make the survey of Ireland depend on actual measurements with the chain, based on a very complete principal, secondary, and minor triangulation, carried out so minutely as to include the fixation of a trigonometrical point for about every 400 acres. In executing this plan he devised and arranged so complete a system of operations, and subdivided the survey into so many distinct branches, proceeding from, but serving as a check on, each other, that he was ultimately enabled to avail himself of the natural aptitude and intelligence of the lower orders of the Irish to form the great mass of the *employés* on the survey, whose number at one period exceeded 2000 persons, mostly from the native population.

In 1825 Major Colby obtained the Duke of Wellington's permission to have three companies of Royal Sappers and Miners raised and trained to assist in carrying on the survey of Ireland, so as to make the work essentially military in its organization: the whole cost of these three companies, containing 105 men each, who could at once be made available for the ordinary military service of the country, was to be defrayed out of the parliamentary votes annually sanctioned for the purposes of the survey.

Major Colby's great difficulty at the outset consisted in the want of an adequate number of trained assistants; he had devised an entirely new system, which could not be practically carried out until he had trained his assistants to the routine of the various processes. Accordingly, the progress of the work at first appeared to be slow and unsatisfactory, and a proposition was made in the year 1828 to introduce a less rigorous but more rapid mode of procedure, and a committee of officers of Engineers, under the presidency of Master-general Sir J. C. Smyth, Bart., was appointed by the Master-general of the Ordnance (Lord Beresford) to inves-

tigate the whole subject; and the result of their labours was, the introduction of less accurate methods, which, however, were cancelled in the course of a few years, and Colonel Colby was permitted to proceed with the work as he originally intended.

Another change was also made in the year 1828. Till then the whole of the correspondence passed direct from the Master-general and Board of Ordnance to the Superintendent of the survey, and Colonel Colby's views on all subjects were explained, either verbally or by correspondence, to the Master-general or individual members of the Board: the sole responsibility for the manner in which the work was carried on thus rested on the superintendent. The change consisted in placing the survey branch of the Ordnance, which Colonel Colby had with so much labour to himself succeeded in forming, immediately under the control of the Inspector-general of Fortifications; so that all reports of progress, applications for increased powers, &c., had to be transmitted to the Board of Ordnance through that officer, as the head of the corps of Royal Engineers. Colonel Colby did not consider the change to be productive in any way of benefit to the public service.

The Report of the Select Committee of the House of Commons had recommended that the survey should be limited to ascertaining and laying down the boundaries of townlands, the roads, streams, and houses, and that it should not embrace the insertion of the fields; but after many counties in the north of Ireland had been completed in this manner, the Government Commissioner for the general valuation reported that the detail thus supplied to him was insufficient, and that he required the principal farms and fields to be shown. In consequence of this representation, all the fields and enclosures were inserted in the maps of the remaining counties; and we understand that the maps of the northern counties, thus left incomplete in the first instance, are now being gradually revised and corrected to make them as perfect as the others.

The engraving of the 6-inch map of Ireland was not originally contemplated by the Select Committee of the House of Commons, but occurred in this manner:—The Valuation Department, under a separate chief, appointed by the Irish Government, required to be supplied with six copies of the maps, and Colonel Colby having ascertained that the cost of engraving the maps on copper would not be likely to exceed the cost of making these six copies, the Irish Government, therefore, determined to obtain a yearly grant of money from Parliament, and to have the maps engraved; so that, at the same cost as would have been necessary for the general valuation to be properly made, the public have been put in possession of the most perfect topographical map, taken as a whole, of any in existence.

In 1828 Colonel Colby selected Major (then Lieut.) Larcom, R.E., as the executive officer for the Irish Survey, head-quarter office at Mountjoy Barracks, in the Phœnix Park, Dublin, to superintend the engraving, to ensure the various branches of the work being carried on in comple unison with each other, and to collect a perfect

record of everything that occurred, so that every document required to establish the authenticity of the work should be carefully preserved; and it is doubtful if anything could excel the admirable manner in which all these objects were effected.

The preliminary difficulties being once got over, and the injudicious attempt to substitute speed for accuracy finally abandoned in 1832, the progress of the survey became considerably accelerated, and the publication of the first county (Londonderry), which took place in May 1833, was rapidly succeeded by that of others, as will be seen by reference to the following table:—

Names of Counties.	No. of Sheets of the Map, including an Index Map.	Date of Publication.
Londonderry	50	May 1833
Antrim	69	February 1834
Tyrone	69	November 1834
Down	58	May 1835
Fermanagh	44	October 1835
Armagh	33	February 1836
Monaghan	35	April 1836
Louth	26	July 1836
Donegal	111	October 1836
Cavan	45	January 1837
Meath	54	April 1837
Leitrim	39	June 1837
Longford	28	January 1838
Sligo	48	— 1838
Roscommon	57	May 1838
Westmeath	41	September 1838
Kildare	41	— 1839
Mayo	124	February 1840
Wicklow	48	May 1840
King's County	48	July 1840
Carlow	27	October 1840
Galway	138	June 1841
Queen's County	38	September 1841
Wexford	55	December 1841
Kilkenny	48	June 1842
Clare	76	December 1842
Waterford	41	January 1843
Tipperary	92	October 1843
Dublin	29	February 1844
Limerick	61	July 1844
Cork	154	August 1845
Kerry	112	November 1847
Total number of Sheets	1939	

Whilst Colonel Colby was occupied in devising and introducing those admirable arrangements, under which the several operations connected with the survey of Ireland were gradually transformed into a beautifully-organised department, he did not neglect the necessary steps for ensuring that the scientific results from the survey of the United Kingdom of Great Britain and Ireland, when finally completed and published, should fulfil the expectation expressed in the concluding paragraph of the Report of the Committee of 1824, viz.: "that the survey would be carried on with energy as well as with skill, and that it would, when completed, be creditable to the nation and to the scientific acquirements of the present age."

He had had considerable experience with Major-general Mudge in the measurement of bases with the steel chain, having assisted that officer at the measurement of the bases on King's Sedgmoor in 1802, and Rhuddlan Marsh in 1806, and conducted the measurement of that on Belhelvic Links near Aberdeen, in 1817, the details of which have not yet been published; and he was perfectly familiar with the methods followed and apparatus used for the like purpose in France, but he was not satisfied with either; he considered that the actual temperature of the measuring chain, in whatsoever manner it might be ascertained, would not be found to accord with the temperature of the air, and that when considerable changes of temperature occurred in short intervals of time, the length of the measuring chain was not the length actually due to the indicated temperature. He, therefore, instituted a series of experiments on the heating and cooling of metal bars, and the changes in this respect that could be produced on their initial states, by varying the nature of their coatings or outer surface, with the object of preparing a measuring rod that should not change its length with changes of temperature; and he eventually succeeded in having an apparatus constructed, consisting of a bar of iron and another of brass, joined together at the centre of their length into one compound bar, which he denominated a "compensation bar," and by which the distance between two dots near the outer extremities of these bars remained invariable in length during very considerable changes of temperature: he also had a microscopic apparatus fitted to similar compensation bars six inches long, so that, by leaving a space of six inches between the outer foci or compensation points of the two outer microscopes, all chance of contact of the ends of the adjoining measuring rods, whilst the operation of measuring was in progress, was altogether avoided.

This beautiful apparatus has been very successfully used in the measurement of a base about eight miles in length, under Colonel Colby's personal superintendence, on the south shore of Lough Foyle in the north of Ireland, during the years 1827–8;* by Mr. Maclear the eminent astronomer at the Cape of Good Hope, in

* See *An Account of the Measurement of the Lough Foyle Base, with its verification and extension by Triangulation*, published by order of the Board of Ordnance in 1847.

1840–1, in the measurement of a base eight miles in length, preparatory to the verification and extension of the Abbé La Caille's arc of meridian, which measurement Mr. Maclear thinks there is just ground for believing is scarcely erroneous to the amount of half an inch, the error being probably much less than this; and in the re-measurement of Major-general Mudge's base on Salisbury Plain, about seven miles in length, in the year 1849, under the direction of Captain Yolland, R.E., employed under the command of Lieutenant-colonel Hall, R.E., who succeeded Major-general Colby in the superintendence of the Ordnance Surveys in 1847; and most admirably in all respects does the apparatus appear to have answered the anticipations of its inventor. A similar set of compensation bars and microscopes, constructed by the same makers (Messrs. Troughton and Simms) for the Hon. East India Company, have been used by Lieutenant-colonel Everest, formerly Surveyor-general, in the measurement of several bases in India.*

Colonel Colby also caused to be constructed two 10-feet iron standard bars, supported on rollers at one-fourth and three-fourths of their length, to afford the means of securing a permanent record of the absolute length of the compensation bars, and the bases measured with them at 62° Fahrenheit; one of these standard bars being intended to be used with the measuring apparatus in the field, and the other to be kept for safety and for record at the head-quarters of the Trigonometrical Survey. He also provided a 6-inch brass standard scale, to be used in preserving a record of the length of the 6-inch microscopic interval between each pair of compensation bars. He also caused two 3-feet iron bars to be made, of a similar construction to the 10-feet iron standards, and compared by the late Lieutenant Murphy, R.E., assisted by the late Mr. F. Baily Professor (then Lieutenant) Johnson, R.N., and Mr. Donkin, jun., in March, 1834, with the Parliamentary Standard Yard, which was subsequently lost at the fire which burnt down the Houses of Parliament in October 1834: these bars and comparisons have since formed a portion of the evidence on which the Commissioners appointed to prepare a new standard have had to depend for the accurate restoration of the lost standard yard.

The observations for the principal triangulation in Ireland, with the exception of the stations connected with and in the immediate vicinity of the Lough Foyle Base, were almost entirely taken by Lieutenant-colonel (then Lieutenant) Portlock, R.E., who also had the charge of the secondary and minor triangulation, and the computations for the supply of distances and altitudes; but that officer was subsequently appointed to conduct the Geological Branch of the Survey, whilst its execution formed part of the duties entrusted to the Ordnance in Ireland.†

* See *An Account of the Measurement of Two Sections of the Meridional Arc in India, by Lieut.-colonel Everest*, &c., published in 1847.

† See *Report of the Geology of Londonderry and parts of Tyrone and Fermanagh*, published in 1843, by Captain Portlock, R.E.

At one period Colonel Colby had it in contemplation to make the Topographical Survey the basis for geological, statistical, and antiquarian researches and surveys, and to connect them with museums of economic geology, both in England and Ireland; but his opinions and efforts in this direction were overruled by the more limited views of the authorities under whom he served.*

When Colonel Colby had succeeded in perfecting all the arrangements connected with the Irish Survey, he next turned his attention to the steps required for improving the accuracy of the one-inch map of England and Wales. Of the work already executed at least two-thirds had been done under the contract system, the surveyors employed being paid at a certain rate for every square mile of ground, for which they prepared a finished manuscript plan; and as no means existed of checking the accuracy of such plans, except by examining the correctness of the detail on the ground, it was found that after the plans had been sent in to the Drawing-room in the Tower, as complete in all respects, very extensive examinations and revisions were generally necessary before they could with safety be traced and transferred to the copper-plates for engraving. Colonel Colby, therefore, decided on having the work surveyed in a more accurate and methodical manner, and a portion of the Eastern Counties and the district of country contained in sheets 79, 80, 81, 82, 87, 88, 89, and 90, comprising parts of Lancashire, Yorkshire, Cheshire, Derbyshire, and Nottinghamshire, have been executed in this manner, and these parts of the one-inch map will, in consequence, be found free from the errors that are occasionally detected in and detract from the value of some of the sheets of South Britain, which have not been revised since their first publication.

The following Table exhibits the order, with dates, in which sheets of the one-inch map were published after Captain Colby succeeded to the superintendence of the Trigonometrical Survey; the local charge of the work at the Drawing-room, during his absence on other duties, having been entrusted in succession to Lieutenant-colonel (then Captain) Mudge, son of the late Major-general Mudge, the late Lieutenant-colonel (then Captain) A. W. Robe, R.E., and Captain Yolland, R.E.

No. of Sheet.	Date of Publication.	No. of Sheet.	Date of Publication.	No. of Sheet.	Date of Publication.
7	August 1822	86	March 1824	43	September 1831
64	March 1824	34	August 1828	55	February 1832
65	— —	44	November 1828	42	September 1832
69	— —	13	May 1830	36	January 1833
70	— —	35	— —	61	January 1833
83	— —	37	— —	73	May 1833
84	— —	54	May 1831	45	October 1833
85	— —	41	June 1831	56	— —

* See *Ordnance Survey of the County of Londonderry—Memoir of the City and North-Western Liberties of Londonderry*, published in 1837.

No. of Sheet.	Date of Publication.
62	January 1834
58	July 1834
57	October 1834
53	— —
46	December 1834
63	June 1835
52	November 1835
71	February 1836
51	June 1836
60	— —
72	— —
59	June 1837
49	August 1837
50	— —
67	December 1837
66	January 1838
38	January 1838*
74	February 1838
68	May 1838
48	November 1838*
75	December 1838
33	January 1839*
77	March 1839
80	May 1840
76	June 1840
2	July 1840*
82	— —
79	— —
87	August 1841
78	September 1841
90	October 1842
81	November 1842
40	February 1843*
89	— 1844
88	March 1844
1	November 1844*

In 1833, we find that Sir Henry (then Mr.) De la Beche made a proposal to the Government to undertake the publication of a geological map of the counties of Devon and Cornwall, and after some consideration it was finally arranged that the Ordnance Survey Department, under Colonel Colby, in conjunction with Sir H. De la Beche, should undertake the work; the Ordnance obtaining the necessary funds from Parliament for its execution, and Sir H. De la Beche being responsible for the geological information engraved on the Ordnance maps under Colonel Colby's direction.

The connexion thus established continued up to the year 1845, when the geological survey was transferred to the department of Woods and Forests (a considerable extent of country besides the counties of Devon and Cornwall having, in the intermediate period, being geologised and published), and it has since received a very considerable increase of strength under its able chief; the engraving is still executed by the Ordnance, but the cost is charged against the Woods and Forests.

Towards the close of the year 1840 the Government, yielding to the urgent representations of various scientific bodies in England and Scotland, consented to extend the advantages which had been found to arise from the publication of the Ordnance Maps of Ireland on the enlarged scale of six inches to a mile $= \frac{1}{10560}$, to the six counties of England remaining unsurveyed, viz. Lancashire, Yorkshire, Westmoreland, Cumberland, Durham, and Northumberland, and to the whole of Scotland, by ordering the survey of those parts to be conducted, and the maps to be engraved on that scale, the publication of the one-inch map for the remainder of England being still continued; and as the memorialists who had brought the subject before the Government had stated the necessity for showing the physical features of the country on the large-scale map, Colonel Colby proceeded to make the requisite arrangements for exhibiting this information by a series of contour or level

* Revised and re-engraved.

lines vertically equidistant from each other, the feasibility of such an undertaking at a moderate cost having been previously ascertained, at Major Larcom's suggestion, by contouring the barony of Enni-howen in the north of Ireland during the years 1839–40, under the immediate direction of the late Captain Bennett, R.E.

Consequent on this decision of the Government, as the force of assistants who had been employed on the Irish survey completed the work they had in hand, they were successively transferred to England, and employed on the surveys of the counties of Lancaster and York; and after awhile a portion of this force was removed to Scotland, for the surveys of the counties of Wigtown and Kirkcudbright.

The discovery of the precipitation of metallic particles by the voltaic circuit about the same time, by M. Jacobi of St. Petersburgh, and by Mr. Spencer of Liverpool, was no sooner made known than experiments were instituted, under the personal superintendence of Major Larcom, for making this important discovery available for the purposes of the Ordnance Survey; and only a very short interval elapsed before these experiments were brought to a successful termination: so that when the engraving of a copper-plate of any sheet of the map had been completed, of which a large number of impressions were likely to be required to meet the wants of the public, a *duplicate* was prepared, by first electrotyping, as the art is now generally called, a *matrix* of the original plate, corresponding in fact with an ordinary impression on paper, but taken *in copper* instead of *on paper*, and made thicker than the paper, and then from this *matrix* electrotyping a second sheet of copper, which will necessarily be a fac-simile of the original plate, and can be substituted for it in printing off the impressions, the original plate being thus preserved intact: in this manner a duplicate of a plate, which might have cost hundreds of pounds to engrave, could be made, at a trifling addition to the first cost of the prepared copper-plate on which the engraving had been executed. This art is now extensively used in the revision of old and insertion of new work on copper-plates, and in making several duplicates of the same engraved plate, on which different kinds of additional specific information can be afterwards engraved; thus the geological lines and characters are now only engraved on duplicates of the original plates of the Ordnance Maps, as the insertion of so many additional lines as are required by the geologist would tend to confuse and disfigure a map only required for the ordinary topographical purposes.

Up to the close of the Irish survey Colonel Colby had trodden in the footsteps of his predecessor, in adopting the low water of ordinary spring-tides as the datum of altitude for the heights inserted on the Ordnance Maps, and the importance of correctly ascertaining such low-water level, for all purposes connected with the drainage of cities and lands but little elevated above the sea, can scarcely be too highly estimated; but the propriety of the low-water datum having been questioned, on the ground of its variability

dependent on position, and the levelling between Axminster on the English and Portishead on the Bristol Channels, made in 1837–8, under the direction of Professor Whewell, at the charge of the British Association for the Advancement of Science, having proved the disagreement between the low and high waters and the very close agreement of the mean-tide levels at these two places, Colonel Colby, in the spring of 1842, after consulting with and obtaining the advice and suggestions of the Astronomer Royal on the subject, took the necessary measures for ascertaining the variations that exist in the height of the high, low, and mean water of the sea on the coasts of Ireland, and for making the operations subservient to improvements in the theory of the tides, by causing a complete series of tidal observations, extending over a period of about two months, to be simultaneously made at twenty-two different stations round Ireland, and by connecting together the zeros of the tide-gauges at these stations by a series of double levellings, so as to reduce all the observations to the same hydrostatic level. The whole of these tidal observations, rather exceeding 200,000 in number, together with the information respecting the several series of levellings, were placed in the hands of the Astronomer Royal towards the end of the year 1842, who, in his valuable paper in Part I. of the *Philosophical Transactions* for 1845, "On the Laws of the Tides on the Coasts of Ireland," founded on these observations, speaks of them in the following manner:—"The circumstances of place, simultaneity, extent of plan, and conformity of plan, appear to give them extraordinary value; and extent of time alone appears wanting to render them the most important series of tide observations that has ever been made."

From the information so gained, Colonel Colby determined that the heights to be inserted in the Ordnance Maps of Lancashire, Yorkshire, and Scotland, and of the towns drawn and engraved on the respective scales of 6 and 60 inches to a mile, should have reference to the mean level of the sea; and accordingly some tidal observations were made at Liverpool, which enabled an approximate mean-tide level to be assumed for the reduction and working out of the altitudes derived from the various lines of levelling branching from that port: and there is every reason to suppose, from comparisons with the height of mean-water at other ports, that the datum of altitude so settled will be found free from any sensible error.

In 1840, Colonel Colby obtained the loan from the Royal Society, of their large 3-feet theodolite constructed by Ramsden, originally a fac-simile of the one belonging to the Ordnance, but which was greatly improved by Captain Kater during the year 1821, by the addition of four vertical micrometer microscopes for reading the horizontal limb; and Colonel Colby further improved this instrument for the observation of angles of elevation and depression, by placing its telescope between two 12-inch vertical circles, read by two horizontal micrometer microscopes attached to the Y supports, and placed opposite to each other, instead of the

single semicircular arc read by one micrometer microscope, with which it was formerly supplied: and with this instrument, and others belonging to the department which became available about this period, he steadily set to work to revise and correct the errors, as well as to supply the many omissions, in the principal triangulation of South Britain, as carried on under the orders of General Mudge, and to extend it over the eastern counties of England, where no triangulation had previously existed on which any dependence could be placed. These errors and omissions had resulted from the hurried manner in which the work was performed, from the very imperfect means placed at General Mudge's disposal, and from the want of a legislative enactment for the preservation of the various trigonometrical observing stations throughout the country, which want sometimes led to a failure of identity between the observing and observed points; so that, all things taken into consideration, it is rather to be wondered at that the work should, generally speaking, be so good as it is known to be.

From the date of the resumption of the principal triangulation of Scotland in 1838, the charge of the several instruments in the field had been placed under Major (then Lieut.) Robinson, R.E.; but that officer quitted the survey in 1843, to assist in the demarcation of the boundaries between the British and United States dominions in North America under Lord Ashburton's Treaty, and the whole of the observers were shortly afterwards brought under the officer in charge of the calculations at the head-quarters of the Survey; and as Colonel Colby had in 1840 sanctioned an experiment for the training and employment of non-commissioned officers of Royal Sappers and Miners, as observers with the large instruments, and for the adoption of a more refined and systematic method of observing, which experiment proved very successful, the selection of good geodesical observers (for which very strong sight probably ranks as the first qualification, and skilful manipulation as the second) could now be made from a larger number of persons than when it was confined to the officers of Engineers employed on the survey, and the cost of the observing was thus very greatly diminished.

Colonel Colby also made another important advance in the execution of Topographical Maps. Knowing the quality of the principal triangulation of the United Kingdom, and the degree of dependence to be placed on it, and feeling assured that the general figure of the earth was sufficiently well known to admit of the accurate calculation and introduction of the latitudes and longitudes on the margins of the sheets (the trigonometrical points within being all laid down by rectangular co-ordinates), without any risk of material error or chance of misleading the public, he sanctioned their insertion on the first sheet of the 6-inch map of Lancashire, which was published in 1846, not to degrees and minutes as it is usually done, but to single seconds of latitude and longitude; which specific information has been continued on all the sheets since published, and which, united to the representation of the form of the ground by contour lines, renders this map, embracing as it does every detail that appears on

the surface of the ground, by far the most perfect of any yet published.

It will readily be understood, that in carrying on the Ordnance Surveys and in making advances and improvements which have been successively introduced into geodesical operations in this country, Colonel Colby had the benefit of most able and zealous assistance from some of the officers of Engineers employed under his orders, as the names of Drummond, Larcom, and many others sufficiently testify; but although the merit of many important improvements relating to the survey may be individually due to the officers who proposed them (and no one was more ready to allow this than Colonel Colby) yet the credit of sanctioning and causing them to be adopted rests entirely with the Superintendent. It appears tolerably evident that Colonel Colby always contemplated continuing the practice of his predecessors with respect to publications relating to the scientific results of the survey, by employing an officer to take especial charge of that particular portion of the work: thus Captain Drummond had to prepare an account of the measurement of the Lough Foyle Base, a duty which devolved on Lieut. Murphy when Captain Drummond was transferred to the political branch of the Government. Lieut. Murphy's labours on this subject were in turn interrupted by his joining Col. Chesney's expedition down the Euphrates, in the year 1835. At a subsequent period, Col. Colby appears to have contemplated completing the work himself, but the occupations connected with the general superintendence of the Ordnance Surveys prevented him from giving his personal time and attention to it, and the preparation of the account of this operation, as well as that of the publication in one volume of the whole of the observations made on the survey with Ramsden's zenith sector, between the years 1802 and 1836, including those made at Balta and Dunkirk in 1817–18, in conjunction with MM. Biot and Arago on the part of the Institute of France, was entrusted to Capt. Yolland, R.E.

It is also understood, that when General Colby quitted the survey in 1847, in consequence of his promotion, the printing of the observations made with Airy's zenith sector for the determination of the latitudes of nineteen stations connected with the several arcs of meridian in the United Kingdom, and exhibiting the effects of local disturbance of the plumb-line at various places to a sensible amount, was in hand: and by the report of the proceedings at the last meeting of the British Association the work appears to have been completed, although it has not yet reached the Society. Col. Colby was endowed with great administrative qualities. Possessed of a very sound judgment and great energy of character, and conscientiously alive to the consequences of failing to carry out the great work with which he had been entrusted in a manner creditable to the country and to the department to which he belonged, he never hesitated to put before the authorities under whom he served his views as to what should or should not be done, and the reasons for it: and these views were usually expressed in very clear and

explicit terms. He allowed no selfish considerations to interfere with the direct line of his duty: for instance, having obtained power from the Master-general of the Ordnance to retain only such officers of Engineers as he found well adapted for carrying on the peculiar duty on which they were engaged, he did not scruple to ask for such officers as he considered most likely to advance the work he had in hand, and to return to the ordinary duties of the corps those whose pursuits or talents were not likely to further the progress of the work.

As an instance of his energy and self-reliance, it may be seen by reference to the returns connected with the Irish Survey presented to Parliament, that after he had fully succeeded, in 1835, in getting his system into perfect working order, and when finished plans of the country were annually completed, to the extent of between two and three millions of acres, he did not hesitate, year after year, to take upon himself the responsibility of exceeding, by large sums, the votes sanctioned by Parliament, rather than to diminish the rate of expenditure and progress by discharging efficient assistants, which reduction would necessarily have had the effect of deferring the final completion of the work for a longer period of time. On the completion of the plans of the Irish Survey, he endeavoured to procure for a few of the officers of Engineers employed under him, whose services he considered to be fully entitled to it, the ordinary mark of military approbation, viz. a step of rank by brevet promotion, that their exertions might thus be recognised in the corps to which they belonged; but he was unsuccessful in his efforts, although the then Master-general of the Ordnance (the late Lord Vivian) fully admitted those services, and apparently only deferred compliance with the recommendation till the engraving should be complete, coupling the recognition of those services with the more pre-eminent ones of the chief under whom they served; and it certainly is to be regretted that this decision should have been permitted by the Ordnance department to be final, at all events as regards Colonel Colby himself, as it is certain that no work executed by the Ordnance during the present century has reflected so much credit on the department as the successful completion of the Ordnance Survey of Ireland, which, in addition to completely serving the purpose for which it was undertaken, has already been used for the following public purposes:—It has formed the basis of the Poor-law Boundaries in detail, determining the localities called Electoral Divisions, according to which the Poor-law Assessment is made; it has served for the Poor-law Valuation, which includes tenements, and which is distinct from the Townland or General Valuation, of all Ireland; it has been used as a means of obtaining an accurate annual return, at very small expense, of every variety of agricultural produce in Ireland; it has been made the basis for the Irish Census, and employed in the sale of property, the boundaries of the fields and farms sold being laid down on the map, and accurately coloured, each map being subsequently enrolled, so that at any future time the property sold can

be traced on the map, and from it identified on the ground; it has further been employed in carrying out the provisions of the Land Improvement Act; and last, but not least, it has greatly facilitated the task of preparing and carrying on, in the most economical manner, the various engineering works executed in that country.

General Colby was an original Member of the Astronomical Society, and one of the Committee appointed to frame rules and regulations for its government, at its formation in 1820. He was also appointed a Member of the Board of Longitude in 1822, and continued to act in that capacity until the Board was dissolved, by Act of Parliament, in 1828. He was also a Fellow of the Royal Societies of London and Edinburgh; of the Geological and Geographical Societies of London; a Member of the Royal Irish Academy, and of the Geological Society of Dublin; an LL.D. of Aberdeen; and a Knight of Denmark.

Major Colby was promoted to Lieut.-Colonel in July, 1825; to Colonel in January, 1837; and to Major-General in November, 1846. He married in 1828, Eliza H., second daughter of Archibald Boyd, Esq., of Londonderry, and died on the 9th October, 1852, at Liverpool, in the 69th year of his age, leaving his wife and seven children (four boys and three girls) to lament the irreparable loss they have sustained.

Samuel Elsworth Cottam was born on the 1st of June, 1801. He left school at twelve years of age, from which period his education was entirely the result of his own efforts. Apprenticed to a large mercantile firm in Manchester, till they retired from business, he continued in the service of the trustees, as agent and confidential servant, till his decease, having been thirty-six years in their service. He became a member of the Manchester Mechanics' Institution in 1825, and was shortly afterwards elected its honorary secretary. He obtained considerable reputation as a popular lecturer, within its walls, on chemistry and electricity; and also delivered numerous lectures on these and other branches of natural philosophy in various parts of the country. He was actively instrumental in establishing the periodical exhibitions of objects of industry, art, and science, which have now grown to such gigantic proportions both in this and the sister kingdom, and which originated with the Manchester Mechanics' Institution. Mr. Cottam had for some time the care of the classes for arithmetic, algebra, and geometry, and his qualifications as a teacher of these branches of knowledge were entirely self-acquired. In 1838 he became Secretary to the Manchester Society of Guardians for the Protection of Trade, and retained this appointment till his death. For a time he was one of the Honorary Curators of the Natural History Society; and he was a member of numerous societies for the promotion of science, not only in Manchester, but also in the metropolis. Amongst others, he took great interest in the scientific *soirées* of the Victoria Gallery, held in the suite of rooms attached to the Manchester Exchange; and when its collection of scientific objects

and apparatus was disposed of—being unwilling to see sacrificed under the auctioneer's hammer the valuable plate electrical machine, and the rest of the electrical apparatus (all of which had been prepared under the direction of that able electrician, the late Mr. Sturgeon, director of the Victoria Gallery)—Mr. Cottam became the purchaser of that apparatus; and one of the latest acts of his useful life was to present this collection to the trustees of the Owen's College. Of late years he had been largely engaged in his profession as a public accountant, in auditing the accounts of various railway companies; and some of his friends trace the foundation of the illness which carried him off, to the great mental labour and unremitting toil imposed upon him in connexion with a large railway company in the North of England. Mr. Cottam died August 7, 1852, leaving behind him a high character for moral worth and scientific utility.

George Dollond, F.R.S., &c., was born in London on the 25th of January, 1774, and having the misfortune to lose his father when very young, his education and subsequent management devolved upon his maternal uncle, Peter Dollond, who was then carrying on the business in St. Paul's Churchyard, to which the nephew ultimately succeeded, (on which he took the name of Dollond, his father's name having been Huggins). Accordingly, he was placed at an early age at the seminary conducted by the late Mr. George Lloyd, at Kennington, then celebrated for the able manner in which his pupils were prepared for their different positions in the world. He was not, however, long allowed the benefit of his instruction, for early in the year 1787 he was sent to the manufactory of Mr. Fairbone, to learn the trade of a mathematical-instrument maker, and in March, 1788, commenced an apprenticeship to the business for which his family were so famed.

There is scarcely anything found in his early years worthy of record, with the exception of the great assiduity with which he applied himself to obtain a mastery of his chosen profession, and the narrow escape he had in 1792 of closing his career from a severe attack of illness, which threatened for a long time to have a fatal termination. Recovered from his illness, and having passed safely through the remainder of his apprenticeship, we next find him on his own account assisting the business of his uncles with his talents and labour, and for a considerable time the whole of the mathematical department of that establishment was the production of his manufactory. The death of his uncle John Dollond, in 1804, a younger brother and partner of Peter Dollond, caused a change in his affairs, for it being found necessary to fill up the gap occasioned by that untimely event, he was immediately selected by his uncle for the post, and in November, 1805, he assumed the position he was fated so long and so honourably to fulfil, both in conjunction with his uncle, until the latter's retirement in 1819, and afterwards on his own account, until the termination of his career. It is unne-

cessary to enumerate the many instruments by which he maintained the celebrity of his establishment, but the Atsmospheric Recorder deserves some notice, as being the closing effort of his long life, and as having obtained for it the reward of the Council Medal of the Great Exhibition of 1851. He was elected a Fellow of the Royal Society on December 23, 1819, and contributed various papers, which were published in the *Philosophical Transactions*. But it is by his connexion with the Royal Astronomical Society that George Dollond will be mostly recognised, for in the course of his long life he was honoured with the friendship of many of the most illustrious representatives of science; and in one of the social gatherings arising out of these intimate relations the formation of the Astronomical Society was proposed. These few lovers of astronomical science formed the nucleus of this body, and it was by their instrumentality and exertions that a Royal Charter was obtained for it, and it was raised to the eminent position which we see it maintaining at the present time. Few of his fellow-labourers in that undertaking survive him; many were removed before the valuable results of their efforts could be known: but he to the last was most indefatigable in the interest he took in the advancement of the Society, and was a constant attendant at its meetings or its council table, until declining strength warned him that the all-powerful mind must at length become subservient to the failings of the flesh, and that a more secluded field of action must for the future be his portion. He lived but a short time in retirement, for the feebleness that had compelled him to resign the management of public business gradually increased upon him, until on the 13th of May, 1852, at the age of seventy-eight, he passed away with scarcely a struggle from a circle he had adorned, leaving behind to posterity an unsullied reputation and an honoured name.

James Edmonstone was born in Edinburgh, February 17, 1802. In early life he had a strong wish for a naval life, which was opposed by his father. This disposition, joined to feeble health, appears to have prevented his settling himself to any occupation, and he passed his youth in the acquisition of knowledge, without any determined purpose. In 1838 he took orders in the Church of England, and proceeded to Sydney, where he exercised his function till the end of 1846, when he returned to England. After doing duty for some time at Romney, he took up his residence at Twickenham, where he formed a large and valuable collection of books, and where he died, March 19, 1852. He was a man of knowledge and energy, and retained his passion for nautical matters to the end of his life. He was an instance of a man whose talents were prevented from acting in the direction to which a strong vocation called them, by what the friends who have furnished materials for this notice call the "great cross and trial of his life" — the refusal of his father to allow of his entering the navy. He was attached to astronomy, as the parent science of

navigation, and to all the branches of knowledge which interest the seaman or the traveller.

Thomas Jones was born on the 24th of June, 1775. In the year 1789 he entered Mr. Ramsden's establishment in Piccadilly, where he acquired a knowledge of the art of constructing and dividing astronomical instruments. Subsequently he commenced business on his own account, and soon attained a high reputation among astronomers for his skill in the construction of instruments of the larger class used in observatories. He assisted, in conjunction with Dr. Pearson, Mr. Troughton, Captain W. H. Smyth, R.N. and others, in the formation of the Astronomical Society. Afterwards he was elected a Fellow of the Royal Society. He was also a member of the Royal Geographical Society, a member of the Institution of Civil Engineers, and a member of the Statistical Society of France. He died on the 29th of July, 1852.

The following astronomical instruments were constructed by Mr. Jones in the course of his labours as an artist:—

A 5-feet equatoreal, Cambridge Observatory.
A 6-feet mural circle, Royal Observatory, Greenwich.
A 6-feet ditto ditto Cape of Good Hope.
A 5-feet ditto Armagh Observatory.
A 4-feet transit circle, Paramatta.
A 6-feet ditto Radcliffe Observatory, Oxford.
A 10-feet transit instrument, A 6-feet mural circle, A 5-feet equatoreal, } Royal Observatory, San Fernando, Cadiz.
A 6-feet mural circle, Trevandrum.

James Lockhart (whose decease was mentioned in the last Annual Report) was born on the 26th of July, 1763, in the city of London. His father was James Lockhart, of Shorfield House, near Rumsey, Hants, formerly a banker at the west end of London. He was a descendant of the old Scotch family of that name, and on the female side from the sister of Oliver Cromwell. He married Miss Gray, a member of the Society of Friends, by whom he had three children.

James Lockhart, the subject of the present memoir, was the eldest child, and received his early education at Reading School, whence some time after he was removed to Eton College, and was there at the same time with the late Duke of Wellington, who, he said, was always remarkable, when studying there, for his taciturnity and grave disposition.

James Lockhart was, from his earliest youth, fond of study, and when he left Eton was considered a very proficient scholar in Latin and Greek, and noted for his Latin versification, a fondness for which he retained throughout his life. On leaving Eton he entered his father's bank, in which he subsequently became a partner. While here, he originated the Cattle Insurance Company. Being of a cheerful and communicative disposition, and possessed

early of ample means, he entered much into society. On retiring from the banking business in 1799, he settled with his family amidst the romantic scenery of the lake district on the banks of Windermere, after losing his wife. This lady was the daughter of Mr. Coxe of Philadelphia, a very extensive owner of land in America, which, however, was wholly forfeited during the American revolution, owing to Mr. Coxe's siding with the royalists. By this wife he had three daughters and one son.

Amidst the repose of this charming scenery he began more zealously to study mathematics, and kept up a constant correspondence with Francis Maseres, Bonnycastle, Peter Barlow, the late William Frend, and Dr. Isaac Milner, President of Queen's College, Cambridge. There he also formed the acquaintance of Dr. Watson, the learned Bishop of Llandaff. About 1801 there appeared a singular work, which much amused the reading world, entitled *Dr. Syntax*. It was Mr. Lockhart who suggested the idea of this work to its author, Mr. Coomb.

In the year 1805 he married his second wife. By this lady, who was much younger than himself, he had eight children,—six sons and two daughters. In 1819 he left the north of England for Holland, to give his numerous family the benefit of a more general education. After passing some time at Leyden, he purchased a comfortable house and large garden in the pleasant suburbs of the ancient town of Haarlem. Here he devoted, with untiring patience, the greater portion of his time to the education of his younger children, in which a knowledge of arithmetic ever formed the basis. Any one, however old, young, poor, or rich, who was fond of mathematics, immediately won his friendship; and many were the young persons to whom he gave mathematical instruction, not for any pecuniary remuneration, but for the mere love of the science he so much admired. In this matter his zeal was unbounded; and many there are still living, here as well as abroad, who have to thank him as the founder of their prosperity. Among his earliest pupils in this way we may mention Dr. Joshua King, now President of Queen's College, Cambridge. This boy he discovered to be a genius, and under his private tuition, in his leisure hours, made considerable proficiency in French and mathematics. Mr. Lockhart was instrumental in sending this young man to Queen's College, Cambridge, with a letter of recommendation to his friend Dr. Isaac Milner, then President of Queen's College, remarking, "I *herewith send you a northern star.*" Mr. Lockhart's method of communicating ideas was particularly pleasant and winning,—indeed, he only considered it his duty as a member of the human family to impart knowledge to others, and continually to instil into the minds of youth grander conceptions of an Infinite Being. He always conveyed to their minds the idea of a *Deus geometrisans* pervading the whole of creation. While in Holland, one of his chief amusements was the cultivation of flowers, particularly of the dahlia. This beautiful flower was then only just becoming known, and had not long been brought from America. In the space of six

or seven years, from one solitary, single-flowered dahlia, he had raised the most choice collection to be found in that country, or perhaps in the world. Persons travelled from a distance to see them. He attended to them himself alone.

As he was possessed of the means of living comfortably and independently, his house was ever open to the scientific; and here, as well as in England, he was accustomed to offer for solution certain algebraical problems to the public, always attaching to each a certain prize in money or books. Among Mr. Lockhart's numerous acquaintance while staying in Holland, we may mention the ex-king of Sweden, Gustavus Adolphus, who was very partial to his company, himself an author, and very fond of astronomy. This unfortunate ex-king used to relate his adventures with all the enthusiasm of a Charles the Twelfth, to whom it was his wish to be compared; possessing, however, but one of his characteristics,—obstinacy!

After staying many years in Holland, he returned to England with his family in 1835 upon the death of his brother, John Ingram Lockhart, who died without issue, and was Recorder of the city of Oxford, and for many years a representative of that place in Parliament. He took up his abode near Aylesbury, whence, in 1837, he removed to Cowley Rectory, near Oxford, more particularly with the view of watching over his late brother's affairs, whose estates had unfortunately got into Chancery. Notwithstanding this harassing suit, his mind ever remained serene, and he seemed to forget all about it on turning to his never-absent companions, the slate and pencil. In 1841, on the sale of the Cowley estate, he removed to Brompton. It was here, in the year 1843, that he had the great misfortune to lose his second wife.

In the year 1845 he took up his abode in the Isle of Skye, among the distant Hebrides, where he took a shooting district comprising the adjoining island of Razay, belonging to the ancient family of Macleod of Macleod. After a sojourn of a couple of years in this island, universally esteemed, he removed into Argyllshire, and took one of the old mansions of the Stewarts of Appin, situated amidst the most beautiful and romantic scenery imaginable. He was so great a favourite with the country people that they gave him the name of Fingal. After the term for which he had taken Fashnacloich had expired, he removed in 1851 to the other extremity of Great Britain, into Somerset, where he resided at Clitsome House, near Washford. Here his usual good health began to decline, and he would remark that he felt at times he was growing old; yet he would frequently mount his horse and ride to the top of some eminence, attended by his Highland servant, for the purpose of indulging in his favourite sport. Only a few days before his death he shot a pheasant, without the use of spectacles, at 63 yards' distance. He died at this house on the 6th of January, 1852, in the 89th year of his age, in full possession of his faculties. There is no doubt that a harassing and expensive chancery suit, with the greater number of his children dependent

on him, hastened his death at last. His last moments were perfectly composed, and he departed with the words, "God has shown me many mercies. I am not afraid to die." He was never ill in his life, and used to say he never felt thirsty. He was a remarkably early riser; and said that most people killed themselves by eating and drinking too much. He left twelve married children behind him, one of whom is also a Fellow of this Society. According to his own request he was borne to the grave by twelve poor men, and lies buried in the churchyard adjoining Nettlecombe Court, the seat of Sir Walter Trevelyan. There the scenery is strikingly picturesque, surrounded by woods and gentle slopes, he having himself made choice of this lovely spot.

He was a man whose knowledge extended over a variety of subjects, ever cheerful in society, with a most winning mode of arguing, deliberate without being cold, mathematical without being dry. In the field of argumentation he often used to say that he had learnt much from the celebrated John Stewart, commonly called "the Walking Stewart," author of the *Opus Maximum*, whose memory he greatly esteemed. Mr. Lockhart's knowledge of languages was also considerable, comprising Greek, Latin, German, Welsh, Dutch, French, Italian, and latterly he studied the ancient Celtic. Of music he was also passionately fond, and played the violin, flute, and flageolet with great taste.

Mr. Lockhart was one instance of the remarkable class who are led by strong predilection to the cultivation of one particular branch of mathematics, to which they devote a part of the leisure of their whole lives. His subject was the numerical solution of equations. From 1813 to 1850 he published various works on this subject, in English and Dutch; and it appears by his correspondence with Maseres that he was a diligent investigator of its history as well as theory. The methods of Horner and Sturm did not come into prominent notice till he was more than seventy-five years of age, yet he made himself master of them and wrote on them. It has been said that the taste for mathematics declines with increasing years. If this be true, the instances to the contrary become the more remarkable; and perhaps no one on record is more striking than that of the cultivator of a branch of algebra who acquired new knowledge of it at seventy-five, and published on it at eighty-seven.

Works published by James Lockhart:—

1. *A Method of approximating towards the Roots of Cubic Equations belonging to the irreducible case.* 1813.

2. *Nieuwe en Algemeene leerwyze, diquadraten op to lossen, waarby de Systemas van Descartes en Euler tot biquadraten met derzelven tweede termen worden voortgezet.* Haarlem, Holland, 1833.

3. *Nieuwe oplossing van Cubiek vergelykingen door juiste uitdrukkingen ook by nadering zonder, beproeving af gissing.* Haarlem, 1825.

4. *Resolution of Equations.* Cowley Rectory, Oxford, 1837.

5. *Resolution of Two Equations.* Oxford, 1839.

6. *Extension of the celebrated Theorem of C. Sturm, whereby the Roots of Numeral Equations may be separated from each other, with copious examples.* Oxford, 1839.

7. *Resolution of Equations by means of Inferior and Superior Limits.* Inscribed by permission to the President and Council of the Royal Astronomical Society. London, 1842.

8. *The nature of the Roots of Numerical Equations. "Longum iter est per præcepta, breve et efficax per exempla."— Seneca.* Fashnacloich, Argyllshire, May 1850. Published in London.

Mr. Lockhart says, in his preface to this work :—"Following the example of Dr. Prideaux, we must beg the reader to excuse, on account of our age, now verging towards 87 years, any errors he may find in this treatise, either of computation or doctrine : no one has assisted in either."

Thomas Norris, Esq., of Howick House, near Preston, Lancashire, died on the 15th of March, 1852, aged eighty-seven. He was born at Croston in the same county, and having received a good provincial education, entered at the age of twenty, as book-keeper, into the eminent firm of Peel, Yates, and Co., cotton-spinners and calico-printers. Having by his industry and business habits obtained a confidential position in the house, he subsequently became a partner. In 1821, Mr. Norris retired from the business, in possession of a large fortune. During the leisure afforded him from business Mr. Norris cultivated, by such means as were at his command, a liberal and elegant taste for science and the fine arts, and on his retirement into private life he collected, with great discrimination and zeal, pictures, coins, minerals, shells, insects, and other objects of natural history. He also indulged his taste in astronomical observations, within a few years of his death ; he was in the daily habit of using the transit instrument, equatoreal, &c. ; he ground and polished glass and mirrors, and constructed microscopes and telescopes. His judgment in matters of art is sufficiently attested by the large and valuable collection which he formed of pictures of the old masters, and he possessed a vivid discrimination of the specific character of objects of natural history. His collections of insects and shells were of considerable value. Mr. Norris was a gentleman of very retiring habits, but exceedingly hospitable and kind to those of kindred pursuits, who were desirous of profiting by the use of his collections. He was extremely prompt and liberal in his dealings ; hence, when any rarity in coins, shells, insects, found its way into the market, he was generally the first to whom it was submitted for sale. In his periodical visits to London, he seldom failed to call in Whitehall Gardens to see Sir Robert Peel, the renowned son of his friend and partner in trade, and the great statesman received his visits with peculiar gratification and interest.

The Rev. Charles Turnor, M.A., F.R.S., was born in Lin-

colnshire on the 10th of August, 1768. He was many years vicar of Wendover in Buckinghamshire. In the year 1818 he was collated to the prebendal stall of Sutton in the Marsh, in the cathedral church of Lincoln. Mr. Turnor was descended from a family of that name of long standing, of Stoke Rochford, and Penton House, in the county of Lincoln. Among his ancestors were Sir Christopher Turnor, one of the Barons of Exchequer, in the year 1660, whose portrait is in Guildhall, as one of the judges appointed to assess the damages occasioned by the great fire of London; and his brother, Sir Edmund Turnor, paymaster to the forces in the reign of Charles I., who was taken prisoner at the battle of Worcester in 1651.

The property of Sir Isaac Newton, about three miles from Stoke Rochford, was purchased by the family about four years after Newton's death, and its integrity remains much the same as in Sir Isaac's time. This led Mr. Charler Turnor during a series of years to make a valuable collection of all he could find connected with the illustrious philosopher.

Mr. Turnor died on the 12th of January, 1853. In private life he was beloved and respected by all who had the pleasure of his acquaintance. Besides being a liberal patron of science, he was a clever artist and an excellent connoisseur of all objects of taste and *vertù*.

The interest which Mr. Turnor felt in the progress of science, more especially astronomy, is amply evinced by his valuable donations to various scientific institutions. In 1836 he presented to our Society a work edited by his brother Edmund Turnor, entitled "Collections for the History of the Town and Soke of Grantham," which, among other matters of interest, contained some authentic memorials of Newton, published for the first time from original MSS. in the possession of the Earl of Portsmouth. In 1845 he also presented two MS. volumes of Astronomical Tables executed in the fourteenth century. An account of these curious manuscripts, drawn up by Mr. Harris, the late assistant-secretary of the Society, is inserted in volume xv. of the Memoirs. Among the benefactions of Mr. Turnor to the Society may be also mentioned the marble bust of Newton, which adorns the meeting-room.

In 1846 Mr. Turnor presented to the Royal Observatory at Greenwich an astronomical clock with gridiron pendulum, by Mudge and Dutton, which was used for some time in connexion with Troughton's mural circle, and which is now in constant use in connexion with the reflex zenith tube of that establishment.

The Council have to announce that Mr. Turnor has bequeathed to the Society the sum of 500*l.* three per cent consols, to be laid out in books for the library. As the news of this legacy is very recent, the Council are not prepared to state the precise mode in which they will proceed to carry into effect the testator's intention. In all probability it will be advisable to form a fund, which will, of course, bear Mr. Turnor's name, the interest of which will be regularly laid out in increasing the library, and, it may be, part of

the principal from time to time, as advantageous opportunities shall occur. By the liberality of authors and institutions, the Society receives almost all new books of astronomy as fast as they appear; and those who know the market of older books are aware that it would be almost impossible to spend 500*l.* to real advantage in a very short time. The perfectly open manner in which this legacy is left, as to mode of proceeding, is, and should be felt as, an additional benefit.

It is understood that Mr. Turnor has also made a bequest to the Royal Society, which includes some interesting memorials of the illustrious Newton.

On the Great Transit Circle of the Royal Observatory of Greenwich we have no remarks to make which would not be a repetition of those made in the Council Report of last year. But it may be interesting to the Society to be informed that an instrument of exactly the same dimensions (differing only by a small quantity in the focal length of the object-glass), and of the same form and materials, is now nearly completed, for the observatory of the Cape of Good Hope. It will be recollected by those members of the Society who are well acquainted with the Greenwich instrument, that Mr. Simms pointed out, after the completion of the instrument, that great facility would be given for the adjustment of the collimators by perforating the central cube. This improvement has been adopted in the Cape transit circle: in other respects it is similar to the Greenwich transit circle.

The Reflex Zenith Tube of the Royal Observatory is now brought into an efficient state. An accident caused an interruption of observations in the spring of last year, and, therefore, the whole number of observations hitherto obtained is insufficient to give means for a definitive judgment on its merits. Their results, however, appear to be exceedingly accurate. It appears (as was thought probable from the first) that the loss of light in the successive transmissions and reflexions diminishes sensibly the brightness of the image, and, consequently, the number of observations which can be secured in a given time. This difficulty may probably be removed by the use of a larger object-glass; meantime it may be observed, that the instrument appears to possess that freedom from the liability to errors, either constant or accidental, which it was Mr. Airy's principal object to obtain.

The use of Galvanism, as an ordinary agent in the daily business of the Royal Observatory, is now almost completely established. One clock is adjusted every day, by a peculiar mechanical arrangement, to accurate Greenwich mean time. By means of this clock, with the sympathetic galvanic construction arranged by Mr. Shepherd of Leadenhall Street, four other clocks in the Observatory (one of them having a large external dial for the use of the public) are kept going to accurate Greenwich mean time. By means of the

same clock, hourly signals are sent to London for use on the railways, the Greenwich time-ball is dropped, and the time-ball erected by the Electric Telegraph Company, on their office in the Strand, is dropped. Within a short time experiments have been made for verifying the apparatus which it is intended to employ for the transmission of longitude-signals to distant observatories.

The American method of observing transits has not yet been brought into action at Greenwich. Although the principal parts of the apparatus are prepared, there are yet some petty defects which have prevented its practical application. The great demand, at the present time, for workmen who are skilled in the constructions required for galvanic telegraphs, causes great delay in the preparation or correction of galvanic apparatus.

Since the last Report, the eleventh volume of the *Radcliffe Observations* has been published, which contains a description of the heliometer, accompanied by an engraving. Mr. Johnson has been enabled during the past year to devote his entire attention to this instrument, and the result has been an extensive series of observations of 1830 *Groombridge*, and 61 *Cygni*, in reference to the question of parallax.

The reductions for the circumpolar catalogue are advancing satisfactorily. It is expected that that work will be ready for press in the course of the present year.

It may be interesting to the Society to be informed, that the Radcliffe Trustees have given directions for laying down a line connecting their Observatory with the Electric Telegraph of the Great Western Railway, and through that medium with the Royal Observatory. That the communication is not already completed is entirely owing to the circumstance of the ground being flooded through which the wire will pass. Mr. Johnson expresses himself much indebted to the Directors of the Electric Telegraph Company for the cordiality and liberal spirit in which they have entertained the project.

The course of observations carried on at Cambridge in the present year is a continuation of that commenced at the beginning of 1850, consisting of meridian observations of the sun, the moon, and moon-culminating stars, the recently-discovered planets and zodiacal stars, and equatoreal observations of the recently-discovered planets and comets.

At the commencement of the current year Prof. Challis made an alteration in the scheme, which had become absolutely necessary on account of the accumulation of unreduced observations. He proposes to confine the meridian observations to zodiacal stars, of which he is gradually forming a catalogue, which, when complete, will include the majority of stars of the 9th magnitude, and brighter, contained in a belt extending 5° on each side of the ecliptic. Meridian observations of the small planets are attended

to at Greenwich, and with means more powerful than those of the Cambridge Observatory. Prof. Challis intends, however, to pursue these bodies with the Northumberland telescope, especially when they are near quadratures, or have become very faint; and the observations will thus be, for the most part, supplementary to the meridian observations at Greenwich. The large telescope will also be employed on classes of observations which entail no large amount of calculation, such as measures of double stars, mapping portions of the moon's surface, &c. By persisting in this plan, Prof. Challis hopes, with the aid of an additional computer, which the University has allowed him, by degrees to bring up the arrear of unpublished observations.

At the Edinburgh Observatory the labours of Prof. Piazzi Smyth begin to assume a more independent character than they have hitherto done. In the course of the last year the observations of 1844-5-6-7, reduced in the usual manner, have been printed and published in one volume, the tenth of the Edinburgh series; thus including the last of the work of the late lamented Prof. Henderson, and accomplishing the end which his successor thought it a pre-eminent duty to strive to obtain.

The subsequent observations of 1849–50–51–52, are far advanced in computation, and some of them ready for the printer whenever the necessary leave to go to press shall have been obtained. Meanwhile observations of stars for proper motion, and of stars observed with comets and small planets, are being proceeded with; and measures to make the Observatory more efficient in instruments and in personal establishment are under the consideration of the Treasury.

At the Observatory of Durham the same course of observation has been generally pursued as in previous years. The principal objects have been the small planets. Mr. Carrington held the office of observer until March. His observations of *Victoria*, *Egeria*, *Flora*, and *Encke's Comet*, have appeared in the *Monthly Notices* and in the *Astronomische Nachrichten*.

Mr. William Ellis became observer at the beginning of April, and his observations, which are to be found in the *Monthly Notices* and *Astronomische Nachrichten*, have included *Flora*, *Melpomene*, *Fortuna*, *Neptune*, *Irene*, *Massilia*, *Eunomia*, *Hygeia*, *Calliope*, *Lutetia*, *Thalia*, *Hebe*, and *Westphal's Comet*.

The right ascensions of many of the stars of reference have been determined by meridian observations with the transit circle.

During the last few months the mounting of the Fraunhofer equatoreal has been rendered more stiff; and the observations since taken with it are regarded as considerably more trustworthy in right ascension.

In the spring a series of direct and reflected observations were made of stars near the zenith, to the north and south, for the purpose of verifying the assumed latitude of the Observatory. The

result of the whole does not differ from that previously assumed, by half a second of space. The longitude having been found by chronometrical comparison with Greenwich, made by Mr. Carrington, the geographical position of the Observatory may be considered to be very nearly determined.

Mr. Chevallier has been in communication with several observatories in which particular attention is paid to those planets, and finds great readiness to concur in carrying out any well-digested scheme of observations.

The following points appear to deserve attention :—

1. Preparation of exact ephemerides, and, perhaps, of maps of stars in the path of each planet.

2. Distribution of particular planets to certain observatories, regard being had to the means of the observatory and its geographical position.

Thus, in the coming opposition, *Egeria* will be invisible at every observatory in the north of Europe ; and often in the north of England the faint planets can scarcely be observed in the summer nights.

3. Observations, early and late, at each appearance, at observatories possessing powerful equatoreal instruments.

4. Good determination, and publication of the position of reference stars.

In speaking of the Liverpool Observatory, we need only repeat in general terms that it continues to justify the high praise which we have always hitherto had the satisfaction of bestowing upon it. It is especially the observatory where the most accurate observations are made for *immediate* use. A striking instance of this kind of astronomical service was lately acknowledged by Mr. Hind, who was enabled, by Mr. Hartnup's excellent observations, to compute a satisfactory orbit of a new planet almost immediately on its discovery. The astronomical observations, taken with the splendid equatoreal during the past year, have been mainly confined to the small planets revolving between *Mars* and *Jupiter*, Brorsen's two comets, and the periodical comet of Encke. All these observations have been published in the *Astronomische Nachrichten*, and a considerable portion in the *Monthly Notices*. As the number of new planets is now so large, and increasing so rapidly, Mr. Hartnup has been advised to limit his attention to those which may be newly discovered, for the purpose of securing an accurate orbit as early as may be, and to observe those already pretty well known only when they pass the meridian of Greenwich by daylight. It may, perhaps, be found necessary to make a further division of labour, and that the astronomers of Cambridge, Durham, and Liverpool should come to some arrangement for a planetary partition.

It is necessary to keep in mind, that purely astronomical observation is by no means the principal object of the Liverpool Observatory. It was founded for the purpose of improving navigation by testing and rating chronometers. It appears that, by degrees,

the utility of this institution is becoming better known to seamen, and is rapidly fulfilling its object. Mr. Hartnup tests all the chronometers sent for trial in different temperatures, and sends them out *with a table of rates corresponding to the temperatures.* The maker is thus enabled to perfect the compensation, or the seaman can allow for the defect. Mr. Hartnup is of opinion, from the records at the observatory, that when the rate of a chronometer is thus corrected, no *constant* difference can be detected between the shore and sea-rates; and that, consequently, local or magnetic attraction, or the motion of the ship, does not sensibly disturb the performance of a chronometer on board our merchant ships.

The time-ball at the Liverpool Observatory is regularly dropped at 1^h P.M. Greenwich mean time, and is of considerable use to chronometer-makers and raters who have not the means of determining the time themselves. But the situation is not well adapted for the use of the seaman *after he has got his timekeeper on board*, and it is, we understand, in contemplation to drop another ball at the same moment from a more conspicuous station, just as is now done at Charing Cross and Greenwich. It is exceedingly desirable to force upon the seaman's notice these aids to the security of navigation; and it is to be hoped that very shortly few ships will leave the Mersey with a badly-rated chronometer, and none without correct Greenwich time at starting.

The meteorological instruments at the Liverpool Observatory are of a very high class, and the results, carefully tabulated, are regularly furnished to the Registrar-General.

The patrons of the Liverpool Observatory have shown their appreciation of Mr. Hartnup's services in the handsomest manner, by making a large addition to his salary, and, as we understand, without any dissentient opinion.

So many well-meant attempts for encouraging science have proved failures, that we cannot help congratulating the founders and supporters of the Liverpool Observatory on their success, which must have exceeded their anticipations; though, from the liberal and business-like way the matter was undertaken, this success has been richly deserved. We trust it may excite emulation and imitation in other quarters.

In the recent numbers of the *Monthly Notices* our members will have seen the prosperous event of Mr. Lassell's mission to Malta. That a person of moderate means, engaged in business, with a wife and family, should have encountered so troublesome, so laborious and expensive an undertaking, for the pure love of astronomy, is a most gratifying occurrence, and shows that the genuine spirit of chivalry still exists in these very material times. We are happy to learn that Mr. Lassell thinks himself repaid, and that his observations of his own satellite of *Neptune*, of the two fainter satellites of *Uranus*, and of the faint satellites of *Saturn*, are so good and so numerous as to settle on a firmer basis the elements of these minute but interesting bodies. Mr. Lassell is on the point

of returning, and while we may congratulate him upon what he *has* done, we trust that his health and strength may suffice for many years to carry on his observations and discoveries successfully at home, though in a less favourable climate than Malta.

The British Association, at its meeting at Belfast in 1852, appointed a committee to consider the steps which might be taken for the establishment, in the southern hemisphere, of a reflecting telescope of large dimensions, to be employed principally in the examination of southern nebulæ. This committee has communicated with the Royal Society, and a joint committee, under Lord Rosse as president, and including several members of this Society, has once met to discuss the subject. It is unnecessary to say that no definitive resolution has yet been passed; but several questions have been started, the consideration of which may probably lead to the introduction of new instrumental constructions, by which the convenience and the power of the mighty telescopes of modern astronomy may be increased; and to the careful selection of stations in which these telescopes may most advantageously be employed.

With the assistance of Mr. William Simms, jun., Mr. Sheepshanks had completed the comparison of all the bars of Baily's metal with bronze 28, before the last summer vacation.* The results, though satisfactory when each observer was considered by himself, did not agree so well when the observers were compared together; and on his return to England, Mr. Sheepshanks suggested that the four selected Government standards should be *recompared*, and by more observers. The Astronomer Royal approved of the suggestion, and, though much to his inconvenience, was kind enough to offer the services of Messrs. Dunkin and Henderson, who are observers at Greenwich. Mr. W. Simms, sen. offered his assistance, which was gladly accepted; and Mr. Warren De La Rue also brought his nice hand and practised eye to the task. Mr. William Simms, jun., as heretofore, adjusted the bars for observation,† and made observations. A considerable number of comparisons of the selected bars with bronze 28 were thus made by each observer, and with the bars in exchanged positions. These observations have just been reduced by the Astronomer Royal, and the results arrived at may be considered, on the whole, as tolerably satisfactory, though short of what Mr. Sheepshanks had confidently expected. The probable error of a *comparison* for each observer is found to be little more than twice the probable error of a *bisection*, as it ought to be; thus showing that the effects of indirect lights, of temperature, of change in the apparatus, &c., are fairly eliminated in the course of the observations. The pro-

* Of the bars thus compared some were objectionable from faults in the division or surface, or as not floating even.

† By availing himself of Mr. W. Simms' assistance in this very trying adjustment, Mr. Sheepshanks was able to employ all his eyesight on the actual comparisons, which would otherwise have been spent on the adjustment.

bable error, too, is satisfactorily small, scarcely exceeding in any case, or for any observer, one division of the micrometer for a comparison.*

The differences of the results of the several observers are larger than would be expected from the probable error of each; for instance, taking the extreme cases among six observers,

		div.	Probable Error. div.
Mr. Sheepshanks finds bronze 10	= bronze 28	−1·28	0·042
Mr. W. Simms — —	= —	−1·83	0·074

Again,

Mr. Simms finds bronze 19	= bronze 28	+0·29	0·097
Mr. W. Simms —	= —	−0·41	0·138

And

Mr. Sheepshanks finds bronze 20	= bronze 28	+0·31	·074
Mr. W. Simms — —	= —	+0·83	·138

Bronze 10 by mistake was measured twice over, and the small probable error of Mr. Sheepshanks is due to the large number of comparisons, at least 400. The number of comparisons by Mr. Sheepshanks is generally three or four times larger than by any other observer. Mr. W. Simms seldom made more than half the number of the other observers. It seems difficult to account for these large differences, except by supposing that each observer sees each division in a manner peculiar to the division, and that we cannot assume the *identity* of the position of a division, as seen by different observers. This indefiniteness is very small, and not likely to affect any useful application, still a limit seems to be shown which, in *optical measures*, no amount of observation in our present state of knowledge can overpass.

The Committee have recommended that of the six bars which are now finally determined, two shall be preserved in public offices, one walled up in some public and fireproof building, one kept at the Royal Observatory, one at the Royal Society, and one, for the present at least, retained in their own hands. This is required for ulterior researches. Twenty-four similar bars have been compared, but their *definitive* lengths are not yet assigned. Several other bars in copper, brass, cast-iron, Low Moor iron, Swedish iron, and cast steel, have been partially compared, and it is intended to make and preserve an accurate type of the yard in each of these metals, thus eluding the practical difficulty of ascertaining the length of bars of different metal sin widely differing temperatures.

* One division of the micrometer = one-millionth of a yard very nearly, or 0·000036 inches. The probable error of 100 observations does not amount to 0·000004 inches in any observer. The Astronomer Royal finds from all the observations, that the probable error of three comparisons is $0^{div.}\cdot55$, or 0·000020 inches for all the observers except the MM. Simms: their probable error is only $\frac{0\cdot55}{\sqrt{2}}$ divisions, or 0·000014 inches. The comparisons are made in sets of three.

A few of these may require further observations, but it is hoped that far the largest portion may be considered as determined, and at the disposal of the Government.

One peculiarity was very clearly marked—the constant tendency of each observer to make the bisection either too short or too full, as compared with another. The bisections of Mr. Sheepshanks are decidedly the shortest, and those of Mr. W. Simms, junr., and Mr. Henderson, the fullest.* The last-mentioned gentleman read each bisection about five divisions higher than Mr. Sheepshanks. The other observers lie between these extremes, Mr. Simms being about half way. A bisection by Mr. Sheepshanks was always declared to be visibly too short by the other observers when they viewed it, and in like manner he always found one of their bisections to be decidedly overdone. No *error* arises from this idiosyncracy, unless the observations of two differing observers should be mixed; but in delicate investigations it seems advisable that the instrumental errors should always be ascertained by the person who makes the observations.

Whether the *touch*-yard, or *end*-measure, which is generally used abroad, will be found less liable to anomaly than the *optical* yard, has not yet been ascertained. It is intended to transfer the optical bronze yard to a touch-yard of cast-steel, and the necessary observations are already commenced. The optical yard has hitherto, in this country, at least, been used in all philosophical inquiries, as in the trigonometrical survey, in measuring the length of the pendulum, &c.; and Mr. Baily's commission, to which Mr. Sheepshanks succeeded, was to verify this form of measure, which is in many respects the most convenient. The commercial measure is a touch-measure, and this form may deserve a preference in some respects: at any rate it will be the duty of the committee to provide a type of each of the greatest possible accuracy, and to give all facilities for comparing and verifying the yard under the two forms.

Some months ago was published the *Second Report of Her Majesty's Commissioners for the Great Exhibition of* 1851, containing proposals for the employment of the surplus funds in their hands. The main proposition, namely, to procure a site at Kensington for a building to be appropriated to many public uses, and, among others, to be partly occupied by the Scientific Societies of the metropolis, was brought by circumstances before the Council. Some remarks made by the Commissioners on the advantages of joining the societies in one locality, if they did not assume the consent of this and other societies, led many to think

* In the microscopes of the standard yard apparatus, parallel wires are used, and the division is placed between them. The observation is pleasant, and not so fatiguing as with cross-wires; but the personal equation is possibly larger. The space between the wires of the right-hand microscope is larger than that between those of the left-hand microscope, and the personal equation is larger in the right-hand microscope, while the probable error of a bisection is not larger.

that such consent could be readily obtained. Perhaps it would be more strictly correct to say, that what was known of the intentions of the Commissioners had created a strong rumour on the subject, which the expressions of the Report were held to confirm. On the simple question of juxtaposition in a locality favourable to the general purposes of our association, the Council, as a body, had never had any discussion, except in one conversation, which ended in an all but unanimous opinion that the Society is now so favourably placed, that no change could be desired. The question of removal to Kensington, for the purpose of obtaining such juxtaposition, had never been brought forward in any shape. When, however, the Report of Her Majesty's Commissioners above mentioned came before the Council, this last discussion was a matter of necessity; and it soon appeared that there was but one opinion, namely, that removal to a distant suburb, or to any suburb, would be in the highest degree detrimental to the Society, if not absolutely ruinous. This opinion the Council expressed in certain resolutions, which were forwarded to Her Majesty's Commissioners, and which have been printed and distributed. As the question will probably receive still more of public attention, the Council invite the attention of the Fellows to the subject. The question of the advantage arising from juxtaposition of the societies in an eligible locality, is one which seems to rest entirely upon the mode which would be adopted of concentrating their libraries and museums. Little business is transacted between the societies as bodies; and that little depends, for facility of transaction, more on the opportunities which the officers have of conferring with each other in the periods intermediate between the meetings, than on the locality in which those meetings take place. All other things being equal, it is clear that the effect of juxtaposition, as such, would be advantageous; it is equally clear to your Council that it would not be so advantageous as to overbalance any moderate disadvantage of local position. Removal to such a distance from the centre of the metropolis as Kensington could not be entertained on any account whatsoever. Of our Fellows who have residences in or near London, two out of them reside east of the meridian of Charing Cross; and this alone would prevent the serious discussion of any proposal to remove as far as the contemplated building at Kensington.

While on this subject, the Council desire to express their sense of the very great benefit conferred on the Society by the Governments which have, one after another, sanctioned this occupation of their present apartments, which they have now held for eighteen years. This feeling is not the less entertained because it is not expressed from time to time: but it would be highly unbecoming to omit some manifestation of it on the present occasion.

The past year has witnessed the discovery of no fewer than *eight* small planets belonging to the group between *Mars* and *Jupiter*, which now includes twenty-three members.

The first was detected on March 17th by Professor Annibal de Gasparis at Naples, and has received the name *Psyche*. The period of revolution is 1848 days, or rather over five years. Professor Gauss has shown that an estimated place of an object (presumed to have been this planet) on the 29th of January previous by Mr. Hind, agrees well with the elements. Its planetary nature, however, was not known to Mr. Hind until the 18th of March, or the night following the actual discovery at Naples.

The second planet was found by Mr. R. Luther, at the observatory of Bilk, near Dusseldorf, on the 17th of April. Upon the proposition of Professor Argelander it has been named *Thetis*. The revolution occupies about 1426 days.

The next planet was discovered by Mr. Hind, at Mr. Bishop's observatory, on the 24th of June, and was named *Melpomene* by the Astronomer Royal. It is one of the nearest of the group, the period being 1269 days, about eight weeks less than that of *Vesta*.

Another planet (*Fortuna*) was found by Mr. Hind on the 22d of August, not far from the ecliptic, in the constellation *Aquarius*. The orbit is very little inclined to that of the earth: the revolution extends to about 1393 days.

The *fifth* planet of 1852 was independently discovered by Professor de Gasparis on September 19th, and by M. Chacornac, assistant to M. Valz at Marseilles, on the 20th of the same month. The inclination of the orbit to the ecliptic is less than that of any other planet, *Uranus* not excepted. M. Valz proposed the name *Massilia* for this object, in which Professor de Gasparis, who has a prior claim to the discovery, appears to have concurred. The period is about 1280 days.

On the 15th of November a *sixth* planet was found at Paris, by M. Hermann Goldschmidt, an historical painter, residing in that city. M. Arago proposed to call it *Lutetia*. It was rather under the ninth magnitude in November, and has now become very much fainter. The revolution occupies 1400 days.

On the night following the last discovery (November 16th) Mr. Hind detected a new planet, with the assistance of one of the ecliptical star-maps at present in course of publication from Mr. Bishop's observatory. It was not much over the 10th magnitude, which is rather beyond the limit of the Berlin Chart. This planet, which performs its journey round the sun in 1816 days, was named by our President, *Calliope*.

The *eighth*, and last planet of 1852, was likewise detected by Mr. Hind on the 15th of December; it was hardly brighter than stars of the 10·11th magnitude, and, being not very far from perihelion, is probably one of the faintest members of the group. On the suggestion of Mr. Bishop it has been named *Thalia*. The period, as nearly as we can ascertain at present, is 1627 days.

Two new comets have made their appearance since our last anniversary, and the remarkable comet of Biela has returned agreeably to prediction.

The first of the new comets was discovered at Marseilles by M.

Chacornac on May 15th, and at Altona by Dr. Petersen on the 17th. There appears to be nothing to distinguish it from a multitude of other telescopic bodies of this nature, whose apparent paths are well represented by the parabola.

The second comet, found by Dr. Westphal at Göttingen, on July 24, and by Dr. Peters at Constantinople about ten days later, possesses a much higher degree of interest, inasmuch as the orbit is undoubtedly elliptical, the period, according to the last calculation, being 61 years. Possibly this object may still be observed with powerful telescopes, owing to its advantageous position in the circumpolar heavens. It would be superfluous to dilate upon the necessity for continuing the observations as long as a glimpse of the comet can be obtained, in order to have the means of predicting the time of its next visit to these parts of space; which will happen, in all probability, before the close of the present century.

The principal component of Biela's double comet would appear to have reached its perihelion three or four days sooner than the date fixed by Professor Santini. The cause of this difference is probably to be sought in the fact of the provisionary elements of M. Plantamour having been adopted as the basis of calculation for 1846. Professor Hubbard of Washington, U. S., thinks there is an error in the computations connected with the perturbations during the comet's last apparition. Both parts of this wonderful body have been re-discovered, though at an increased distance from each other. Signor Secchi, Professor Challis, and the astronomers at Berlin, have observed one or other of these parts, notwithstanding the serious interruptions they experienced from the comet's presence in the morning twilight.

In the last Report of the Council, allusion was made to a new method of computing numerically the special perturbations of planets, for which Physical Astronomy is indebted to Professor Encke. The method, as first explained, applied to the disturbances produced in the rectangular co-ordinates. Dr. Brunnow and Professor Hansen have since introduced modifications of this method, applying to polar co-ordinates. Dr. Brunnow's form of computation gives the numerical values of perturbation in true longitude, radius vector, and latitude; Professor Hansen's, following out the form of theory which he has so successfully employed in other cases, gives the perturbation of mean longitude. It is considered by Professor Encke that, so long as the perturbations are confined to the first order of disturbing forces, these methods are preferable to his original method: they do not, however, apply with the same facility to higher orders of force.

Among the most remarkable applications of astronomical results to determinations of general interest, we may cite the recent calculations of the eclipse of Thales. This, as is well known, formed the subject of a very valuable paper by Mr. Baily (the first of his

astronomical memoirs). Proceeding from the elements of Bürg's tables, Mr. Baily found that no eclipse but that of B.C. 610 could correspond to the historical account: at the same time he pointed out, that the inability of these elements to represent another eclipse of great historical interest (the eclipse of Agathocles) threw doubt on the calculations. Since that time, theory has made important advances, and observations and the reduction of observations have been very greatly improved. In the last year, the demands of chronologers induced two of our members, the Astronomer Royal and Mr. Hind, to recalculate this eclipse. The result has been, that the date of B.C. 610 can no longer be admitted; and the year B.C. 585 appears to be established, beyond the possibility of future doubt, as the veritable date of this remarkable eclipse.

The Astronomer Royal (one of the observers who saw the red projections from, or from behind the edge of the moon, in the total eclipses of 1842 and 1851), with the assistance of Mr. Nasmyth, who contributed the most important part of the apparatus, has endeavoured to ascertain whether red projections from the sun's edge can be seen at times other than those of a total eclipse. For this purpose, a telescope mounted in a large ball-and-socket joint, and with its eye-end projecting into a dark room, has been made to form an image of the sun, the light of which passed through a circular hole (very little exceeding it in diameter) into a blackened box; and it was hoped that any projections from the sun might then be seen depicted on the ring of white paper surrounding the hole. In this manner numerous observations were made during the summer of 1852. The results, however, to this time, are entirely negative; nothing whatever has been seen which could be conceived to arise from any real projection from the sun's limb.

The astonishing discovery (announced in the Council's Report of the last year), that within the inner brilliant ring of *Saturn* there is a faint dusky ring of great breadth, and the still more astonishing discovery by Mr. Lassell, that this dusky ring is partially transparent, have directed the attention of literary astronomers to the history of the former observations of *Saturn's* ring. Much interest has been excited by M. Otto Struve's collection of the observations made at different times from the age of Huyghens, and by his inference that, while the outer edge of the compound bright ring has undergone little alteration, the inner edge has been gradually approaching to the ball of *Saturn*. It appears, however, that, to give these observations their full value, it will be desirable that observations on *Saturn* be repeated with Huyghens's object-glasses, still preserved (it is understood) in the care of the Royal Society.

Very careful drawings of the appearances of *Saturn* have been communicated from time to time to the Society by MM. Lassell, Dawes, and De La Rue, and the last-named gentleman has engraved and distributed copies of the appearances which *Saturn should*

have, according to the data of the *Nautical Almanac*. It is his opinion that in this case the greatest final accuracy is to be arrived at, by directly comparing the graphical results of measurement with the planet itself. Mr. De La Rue has suggested that some additional data in the *Nautical Almanac* would greatly facilitate the accurate representation which is thus required. He has also expressed his intention of embodying in one careful drawing all the results which may be considered as *certainly ascertained* with respect to *Saturn* in the course of the past year by himself and MM. Lassell and Dawes.

Several MS. volumes, containing the observations for the Triangulation of the Cape, have been transmitted to the Royal Observatory, Greenwich. It is greatly to be hoped that active measures may soon be taken for reducing in a systematic way these observations, and for exhibiting to the public their results.

The Society has learnt long since, from the communications of Mr. Maclear, that the bright star *α Centauri* appears to have an annual parallax of about one second of arc. From later communications of the same observer, it appears that the neighbouring star *β Centauri* has an annual parallax of nearly half a second. From the deficiency (at this time) of observations, and from the smallness of the coefficient, we cannot answer with the same confidence for the certainty of this result as for the former; but we have no reason for doubting its accuracy.

It was hoped that, at the last return of Encke's Comet, observations of that body might be obtained at the Cape of Good Hope, which would have been valuable for its theory; and every preparation was made at the Cape Observatory for securing them. The unfavourable position, however, of the comet, and the bad weather which prevailed during the time of its appearance, have greatly diminished the value of the few observations which Mr. Maclear was able to make.

The extended recognition of the value of observations by reflexion from the surface of quicksilver, even for transits and other instruments, for which spirit-levels alone were (till lately) universally employed, has induced several observers to turn their attention to the best methods for quieting the tremors to which the surface of the quicksilver is liable from the most trifling cause of disturbance. In France, MM. Séguin and Mauvais have used, apparently with success, the method of suspending the quicksilver trough by three or four strips of vulcanized caoutchouc. In England, the Rev. C. Pritchard has practically introduced the use of copper or silver troughs, whose surface is amalgamated with quicksilver; the fluid quicksilver in these troughs attaches itself to the amalgamated surface in the same way as water in a wetted dish: it lies in a very thin stratum; and it comes to rest very quickly. The latter method is now in use at the Greenwich Observatory.

Allusion was made in the Council Report of last year to the progress of M. Rümker's labours in the construction of his Catalogue of 12,000 stars. The Council have now the satisfaction to state that this great undertaking, upon which M. Rümker has for many years bestowed so much attention, has finally been completed. It would be difficult to over-estimate the boon which our Associate has conferred upon astronomers by the publication of this catalogue, which is destined to form a durable monument of the perseverance and ability of its author, and of his unwearied devotion to the cause of astronomical science.

During the past year Mr. Grant has completed his *History of Physical Astronomy*, a work the first numbers of which formed his introduction to the Society. It is very seldom that the Council is called upon to notice any work of so peculiar a merit. If Mr. Grant had possessed perpetual access to extensive libraries and peculiar inducements to consult them,—if he had passed many years in historical research, had matured his judgment by long habits of discussion with others of like pursuits, and had learned by small attempts how to venture on larger efforts, the production of a sustained history, of extent and matter such as he has published, would have excited admiration, and would have called forth some remark on the true secret of success in such undertakings. But when it is considered that the author had no more connexion with libraries than any one may command for the asking, and no peculiar calling to tempt him into research,—that he has not reached middle life, and that his opportunities were furnished, as is understood, by the leisure of ill health or convalescence,—that he had, before the publication of his work, little or no sustained opportunity of communication with those who could have helped to direct his reading or form his judgment,—and that he never published anything whatever previously to the appearance of this well-conceived, well-executed, and greatly-wanted history,—the Council, while they state that the work has taken a place among standard books of history from its first appearance, under circumstances which greatly enhance the merit of its author, congratulate the Society upon the prospect of numbering Mr. Grant among its executive members.

With regard to annual parallax, the Council deem it proper to bring prominently before the notice of the Society a remarkable paper, by M. Wichmann on the parallax of the celebrated star *Groombridge* 1830, which has recently been published in the *Astronomische Nachrichten.** This star, it will be remembered, has the largest proper motion at present known, exceeding 7″ in arc, and, in consequence, various attempts have been made at different places to determine its parallax, the antecedent probability being great that its distance would be easily measurable. The discovery of

* Nos. 841–44.

the proper motion was published by Argelander in the year 1842, and Bessel was induced to give immediate directions to Schlüter, his assistant, to commence a series of measures with the Königsberg heliometer. These measures were begun in October, 1842, and were terminated abruptly near the end of August, 1843, by the illness and subsequent death of the observer. M. Wichmann was then charged with the continuation of the observations and the completion of the investigation, but more pressing duties relating to the observation of planets and comets prevented him from completely fulfilling the wishes of the great astronomer till the year 1851.

The paper under review gives the results of the complete discussion of his own measures, together with those of his predecessors, and occupies more than four complete numbers of the current volume of the *Astronomische Nachrichten*.

In the remarks made upon this paper it is impossible to give more than a sketch of the details of the discussion into which the author is led, neither would the Council be understood to express any decided opinion upon the subjects in dispute between him and other astronomers; the object is only to set clearly, yet briefly, before the Society the chief circumstances as yet elicited by observation respecting this baffling and mysterious star, and to recommend it to the notice of other astronomers who are furnished with instruments enabling them to repeat the measures for the determination of its parallax.

M. Wichmann gives, first, a short historical summary of the attempts of other astronomers. In the year 1846, M. Faye, by transit observations made with the Paris equatoreal, determined the parallax to be $1''{\cdot}08$, and, by this striking result, drew the attention of others to the star. Peters, by discussion of his observations made at Pulkowa with Ertel's circle, in 1843, subsequently determined its parallax to be $0''{\cdot}226$; whilst the author's discussion of Schlüter's observations gave $0''{\cdot}18$. Finally, Otto Struve, by micrometer-measures of differences of north polar distance, made with the great refractor in 1848 and 1849, found a questionable parallax less than $0''{\cdot}1$; a result at variance not only with Faye's value, but with that deduced from Schlüter's observations.

Omitting the author's remarks on the previous discussion between MM. Struve, Faye, and himself, we proceed to explain the method insisted upon by him as proper to be used in his own investigation.

M. Struve had insisted upon the necessity of basing the determination of the parallax upon the *difference* of the observed distances of the star in question from two comparison stars, rather than upon separate discussions of the *absolute* distance of the star from each of the others, on the principle that "the difference between two nearly equal magnitudes can be much more accurately measured than the magnitudes themselves." The author observes that, with regard to the Königsberg heliometer, the greater accuracy

of the differential measures depends less on the truth of this principle than in the observed fact, that in the measure of large distances unavoidable errors occur, which for smaller distances either do not exist at all, or are got rid of as purely casual errors of observation. (In the sequel the author enters minutely into the discussion of the law of increase of errors as the measured distance increases, but we have not space for these details.) To provide, then, for the greatest possible accuracy, the Königsberg observations have been so arranged that the *two* distances (of the star from the two comparison stars) are not observed absolutely, but only *one* of the distances, and the *difference* between it and the other. "The measure of the difference of the distances is thus," he says, "quite independent of the measure of the latter, and the deduction of the result of the difference measures does not at all depend upon our knowledge of the distances of the comparison stars. But," he continues, "from the difference of the distances nothing else is ultimately derived than the excess of the parallax of Argelander's stars above the arithmetical mean of the parallaxes of both the comparison stars. The question, then, whether the latter, in virtue of the observations, are to be regarded as equal to each other, and, therefore, as probably indefinitely small, can only be resolved if, besides the difference of the distances, their sum be also brought into the investigation, or both stars (of comparison) be separately treated; and a reduction of the observations which, as Struve indicates, regards only the difference, could not be regarded as exhausting or setting at rest the subject."

According to this principle, then, the author arranges his equations of condition in two sets, one of which involves the differences, and the other the sums of the measured distances, in the following way. The distances from each comparison star actually measured on each day are reduced to the mean distance for an assumed epoch, and are then strictly compared with the absolute mean distances of the stars for the same epoch, which had been previously deduced, with great care and labour, by means of all the heliometer measures of distance, in connexion with the best meridian observations of the star in question, *Groombridge* 1830. The differences between the separate mean distances for each day, and the absolute mean distances thus computed, are supposed to be mainly due to parallax; but, to avoid the error which might be induced by an error in Bessel's temperature correction for the screw of the heliometer, this latter effect is also introduced as an unknown quantity into the equations of conditions. Taking, then, the two sets of measures, two sets of equations are produced, involving the differences above-mentioned, the relative parallax coefficient for each comparison-star, the temperature coefficient, and a constant.

By subtracting and adding the equations thence arising, two other sets are derived; the first of which involve the *differences* of the measured distances, and the sum and difference of the relative parallaxes, the other set involving the sum of the measured distances and the difference and sum of the relative parallaxes, the

coefficients of the difference of parallaxes in the first set being the same as those of the sum of parallaxes in the second.

In Schlüter's measures, the stars of comparison (a) and (a') were at nearly equal distances on opposite sides of A, the principal star, (a) preceding by 34′ in right ascension, and being about 3′ south of it, while (a') followed by 34′½ in right ascension, and was nearly 5′ north of it. Wichmann added another comparison star (a''), near (a'), in the same parallel with A, and following it by 30′ in right ascension. It thus happened that the first set of equations involved essentially only the sum of the relative parallaxes, and the other only the difference of the same; the coefficient of the difference of parallaxes in the first set, and of the sum in the second, being either nothing or a very small quantity. The author treats with the utmost rigour Schlüter's observations, and deduces the following result from the difference equations; viz. that the half sum of the relative parallaxes for both stars, or the parallax of Argelander's star diminished by the mean of the parallaxes of the comparison-stars, is + 0″·180, with the probable error 0″ 017.

Discussing, in a similar way, his own observations made in 1851, but taking separately the measures of distance, A a' — A a, and A a — A a'', he deduces for this half sum of relative parallaxes, + 0″·0855 in the first case, and + 0″·0892 in the second, the probable errors being 0″·018 and 0″·023 respectively. It may be mentioned here, that the above results are deduced on the supposition (ultimately to be proved) that the difference of the relative parallaxes of a and a', or of a and a'', is equal to 1″·17; but this is of no importance with regard to the substantial accuracy of the above results, since these differences of parallaxes are multiplied in the final values of the relative parallax of Argelander's star by the factors — 0·005 and + 0·0115.

It is clear, then, that the parallaxes of (a') and (a'') are sensibly equal, and of very small amount; and this the author conceives may be received as an incontrovertible fact.

He next proceeds to discuss his equations arising from the sums of the observed distances, and he first observes, that in the discussion of Schlüter's observations, the observations of the sum of the distances of a and a' from A gave a difference of about 2″ between the summer and winter observations, the summer measures being the larger. This result was confirmed by his own observations, both as to the general fact and the amount of the difference, and could only be accounted for by a supposition of parallax in one or more of the stars, or by the effects of temperature. It somewhat unfortunately happens, that the maximum effects of relative parallax and of temperature pretty accurately coincided for the stars in question. Hence it became a very difficult matter to disentangle the separate effects, and it was evident that both effects could not be determined simultaneously from the equations.

The author is on this account obliged to make two separate hypotheses, the first being that the difference of the parallaxes of a and $a' = 0$, and that the whole observed difference between the

summer and winter measures is the effect of temperature; the second being, that the effect of temperature can be correctly computed by Bessel's estimation of it, and that the whole difference is the effect of parallax.

By a rigorous discussion of Schlüter's observations it is found that, on the first hypothesis, the effect of temperature results five times as large as that deduced by Bessel; and on the second hypothesis, that the excess of the parallax of a above that of $a' = + 1''{\cdot}148$.

Since, however, Wichmann is far from thinking that the question is decided by this result, he submits the hypothesis to the far more searching test of his own observations of 1851, and finds that the first hypothesis will not in any degree satisfy the equations, but that on the second hypothesis the difference of the relative parallaxes of a and a' taken as before is $+ 1''{\cdot}186$, and that the equations are perfectly well satisfied. He is so well satisfied with this conclusion, that he announces confidently that "*the existence of a considerable parallax of the star a may be looked upon as demonstrated.*"

Combining then Schlüter's result with his own, he finds the excess of parallax of a above a' to be $+ 1''{\cdot}17$, with probable error $0''{\cdot}08$. He then sums up the facts, which he considers to be adequately proved by his investigation, in the three following propositions:—

1. In the observed differences of the distances $A\,a' - A\,a$ and $A\,a - A\,a''$ there is shown a periodical change, which is of such a nature as to receive a satisfactory explanation on the supposition that the parallax of A is greater by $0''{\cdot}135$ than the mean of the parallaxes of a and a'.

2. A far more marked periodical change, still more accurately deduced, is shown in the observed sums of the distances, and is of such a nature as to receive a perfectly satisfactory explanation on the supposition that the parallax of a is greater by $1''{\cdot}17$ than those of a' and a'', but it cannot be explained by the influence of temperature on the heliometer.

3. The residual errors resulting from the employment of the above suppositions are sensibly greater for the sum measures than for the difference measures; the proportion of the probable error of a difference measure to that of a sum measure being as 1 : 3.

Finally, by assuming that the parallaxes of a' and a'' are insensible, he deduces the following definitive results:—

Parallax of $a = 1''{\cdot}17$
Parallax of $A = 0''{\cdot}71$

In conclusion, the author enters into a critical comparison of the results of Faye, Peters, and Otto Struve with his own, for which we may refer to his paper, as well as for the details of his investigation, which we have not found space to advert to. Indeed, without an attentive perusal of this remarkable paper, no adequate idea can be gained of the skill, labour, and perseverance with which the whole investigation has been conducted.

In concluding our remarks on this interesting subject we would draw attention to the fact, that the large parallax of the star a relatively to the stars a' and a'', is based almost solely upon the circumstance of the heliometer having given for the measured distances of the principal star from a and a' a result greater in summer by a conspicuous quantity than that given in winter, and upon the impossibility of adequately accounting for this *undoubted* fact, by the only obvious supposition excepting that of parallax, that is by the effect of temperature on the screw of the heliometer. It will immediately be suggested to the minds of all astronomers conversant with such measures, that the best *experimentum crucis* that can be used to set this point at rest will be a set of measures of the distance of two small stars similarly situated, where there is no suspicion of a sensible parallax, made as nearly as possible under the same circumstances. It would, indeed, be better to choose stars whose line of direction is nearly at right angles to that of a and a', since then the possible parallactic effect and the temperature effect sought for would have their maxima at different times of the year, and could be brought out separately by means of the same equations of condition.

For the present, though we forbear expressing any opinion upon the degree of certainty of M. Wichmann's definitive results, we cannot avoid expressing our admiration of the extraordinary degree of care, zeal, and ability displayed in his very valuable contribution to parallactic researches.

Catalogue of the Minor Planets at present known, arranged in the order of discovery.

Reference No.	Planet.	Date of Discovery.	Name of Discoverer.
1	Ceres	1801, Jan. 1	Piazzi
2	Pallas	1802, March 28	Olbers
3	Juno	1804, Sept. 1	Harding
4	Vesta	1807, March 29	Olbers
5	Astræa	1845, Dec. 8	Hencke
6	Hebe	1847, July 1	Hencke
7	Iris	1847, Aug. 13	Hind
8	Flora	1847, Oct. 18	Hind
9	Metis	1848, April 26	Graham
10	Hygeia	1849, April 12	De Gasparis
11	Parthenope	1850, May 11	De Gasparis
12	Victoria	1850, Sept. 13	Hind
13	Egeria	1850, Nov. 2	De Gasparis
14	Irene	1851, May 19	Hind
15	Eunomia	1851, July 29	De Gasparis
16	Psyche	1852, March 17	De Gasparis
17	Thetis	1852, April 17	Luther
18	Melpomene	1852, June 24	Hind
19	Fortuna	1852, Aug. 22	Hind
20	Massilia	1852, Sept. 19	De Gasparis
21	Lutetia	1852, Nov. 15	Goldschmidt
22	Calliope	1852, Nov. 16	Hind
23	Thalia	1852, Dec. 15	Hind

Papers read before the Society from February 1852 to February 1853.

1852.

Mar. 12. On Baily's Beads, as seen in Eclipse of July 28, 1851, Prof. Powell.

On the Parallax of *β Centauri*. Mr. Maclear.

On a Contrivance for connecting a Clock Motion to an Uniform Rotation. R. L. Jones, Esq.

On Latitude from Extra-meridian Observations. Mr. Diggins.

Account of Solar Eclipse, July 28, 1851. Mr. H. F. Talbot.

Observations of Encke's Comet. Prof. Bond.

Solar Eclipse. J. Hartnup, Esq.

Various Observations. M. Rümker.

Observations of Encke's Comet. Mr. Boreham.

On Solar Spots. Capt. Shea.

On the supposed Period of Revolution of Great Comet of 1680. Mr. Hind.

On the Satellites of *Uranus*. Mr. Lassell.

Ditto ditto Mr. Lassell.

Remarks respecting *Uranus*. Mr. Lassell.

On *Neptune* and his Satellites. Mr. Lassell.

April 7. Observations of small Planets. Mr. Carrington.

Ditto ditto Mr. Carrington.

On Circle Dividing. Rev. R. L. Jones.

Micrometrical Measurement of ξ *Ursa Majoris*, *&c.* Mr. Miller.

Coefficients of Planetary Perturbations. Mr. Wackerbarth.

Observations of small Planets and Encke's Comet. Mr. Hartnup.

Observations of small Planets. Mr. Carrington.

On the Southern Stars. Lieut. Gilliss.

On a Solar Eye-piece. Rev. W. R. Dawes.

Note on De Gasparis' new Planet. Mr. Hind.

Mars in Opposition, 1852. Mr. De La Rue.

May 14. Opposition of *Mars*. Mr. Maclear.

De Gasparis' Planet. Dr. Petersen.

Observations of De Gasparis' Planet. Sig. Secchi.

Observations. M. Rümker.

Rectangular Co-ordinates of Luther's Planet. Prof. Chevallier.

On luminous Bodies telescopically visible in Sunshine. Rev. W. R. Dawes.

On the remarkable Phenomenon seen April 8, 1852. Mr. Wilcox.

Ditto ditto Mr. Hall.

Ditto ditto Mr. Ayrton.

Correction of an Error, &c. Lord Wrottesley.
On the Longitude by an Altitude of the Moon. Mr. Aske.
Tables of the Moon's Parallax. Mr. Adams.

June 11. Discovery of *Psyche*. Sig. De Gasparis.
Proposal to note Dimensions of Telescopes. Mr. Nasmyth.
Note on Galle's Discovery of *Saturn's* Dark Ring. Rev. W. R. Dawes.
Letter from the Madras Observatory. Capt. Jacob.
Elements and Ephemeris of *Psyche* and *Thetis*. Mr. Vogel.
Letter to Mr. Grant on estimating Solar Heat. Signor Secchi.
On Vision. Lieut. Hardy.
On a remarkable Appearance at Sunset in April last. Mr. Gray.
On the same Appearance. Captain Shea.
On the Rose-coloured Prominences seen during Total Solar Eclipses. Mr. Babbage.

Nov. 12. Micrometrical Measurements of γ *Virginis*. Mr. Fletcher.
Observations. Mr. Hartnup.
Ditto Mr. Boreham.
Ditto Messrs. Cooper and Graham.
Occultations. Mr. Snow.
On the Comet of 1689. Mr. Vogel.
Observations of Chacornac's Comet. Mr. Bond.
Discovery of *Melpomene*, *Fortuna*, and a Nebula. Mr. Hind.
Discovery of *Massilia*. Dr. Petersen.
Observations, &c., of new Planets and Westphal's Comet. M. Rümker.
Elements and Ephemeris of *Fortuna*. Mr. Vogel.
Observations. Prof. Johnson.
Observations of *Fortuna*. Mr. Boreham.
Planetary Observations. Professor Chevallier.
Observations of *Hygeia*. Mr. Ellis.
Observations of Petersen's Comet. Mr. Maclear.
Ephemeris of *Hygeia*. Professor Chevallier.
On the Appearance of *Saturn*. Rev. W. R. Dawes.
Appearance of *Saturn* at Valetta. Mr. Lassell.

Dec. 10. On a new Portable Transit. Mr. Rothwell.
On an Improvement in Machine for grinding Specula.
Letters to Mr. Sheepshanks and Mr. De La Rue on *Saturn*. Mr. Lassell.
Appearance of *Saturn*. Rev. W. R. Dawes.
On the Brilliancy of the Variable Star α *Orionis*. Mr. Fletcher.
Observations. M. Rümker.

Elements and Ephemeris of *Massilia*. M. G. Rümker.
On a Contrivance for observing Faint Objects. Mr. Pogson.
Proportional Trigonometry. Mr. Timms.
On the Fallacies of Vision. Lieut. Hardy.
On a Mode of supporting Specula. Lieut. Hardy.

1853.
Jan. 14. Discovery of *Thalia*. Mr. Hind.
Letter from Valetta. Mr. Lassell.
Proposal for observing Red Prominences on Sun's Edge. Mr. Nasmyth.
Expression for Kepler's Problem. Prof. Hansen.
Astronomical Observations. Dr. Drew.
Appearance of *Saturn*. Mr. Hind.
Probable Temperature of *Jupiter* and *Saturn*. Mr. Nasmyth.
Discovery of *Calliope*. Mr. Hind.
Discovery of *Lutetia*. M. Le Verrier.
Additional Remarks on Cosmical Speculations. Mr. Dempster.
On the Use of Mercury for Adjustments of Astronomical Instruments. Rev. C. Pritchard.
On Improving the Action of Telescopes. Mr. Grove.
On the Cause of large Quantity of Rain in 1852. Captain Shea.

List of Public Institutions and of Persons who have contributed to the Society's Library, &c. since the last Anniversary.

Her Majesty's Government.
Royal Society of London.
Royal Society of Edinburgh.
Royal Geographical Society.
Royal Asiatic Society.
Royal Institution.
Geological Society.
Linnean Society.
Zoological Society.
Cambridge Philosophical Society.
Society of Arts.
Manchester Philosophical and Literary Society.
British Association.
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Institution of Civil Engineers.
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Imperial Academy of Sciences at Vienna.
Imperial Observatory at Vienna.
The Observatory at Bonn.
The Observatory at Milan.
The American Philosophical Society.
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The Editor of the Athenæum Journal.
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Address delivered by the President, J. C. Adams, Esq. M.A. F.R.S., on presenting the Gold Medal of the Society to Mr. Hind.

Gentlemen,—You have heard from the Report which has just been read how much reason we have to congratulate ourselves on the present state and future prospects of our science. Never was there a time when greater vigour and activity were exhibited in the promotion of it. Nor is this activity confined to one country, or devoted merely to one department of astronomy. Whether we regard the introduction of improved instruments and methods of observation, or the more rigorous discussion to which the observations are submitted, the formation of extensive catalogues of stars, the discovery of new members of our planetary system, or the closer and more systematic scrutiny and examination of those which are already known, in every direction we find the most satisfactory evidences of progress.

One of the most prominent features of astronomical discovery for several years past, has been the continual addition of new members to the remarkable group of small planets between the orbits of *Mars* and *Jupiter*, and the year just ended has been distinguished beyond all precedent in this respect.

Since our last anniversary meeting no fewer than eight of these bodies have been brought to light, and the supply seems to be inexhaustible. New discoverers have made their appearance on the field, while those who have already distinguished themselves seem to have acquired a new aptitude in the search.

It is gratifying to find that one of our own body has been the very foremost in this noble career of discovery; and to him, in testimony of our appreciation of his well-directed and successful labours, the Council has awarded the medal, which it is my pleasing duty this day to present.

Skilfully using the excellent instrumental means placed at his disposal by the enlightened liberality and scientific zeal of Mr. Bishop, and in spite of the interruptions occasioned by a climate, the disadvantages of which are peculiarly felt in researches of this nature, Mr. Hind has added no fewer than eight planets to our system, four of which have been found in the course of the past year. After this, I feel that it is unnecessary to add another word in justification of the award of your medal. Mr. Hind's discoveries are of a nature to be understood and appreciated by all; and I shall, therefore, confine myself to a very brief notice of some circumstances connected with them, and to a few remarks on the conclusions to which they seem to point, respecting the constitution of our planetary system.

The first five of Mr. Hind's planets were found by comparing the heavens with the excellent and well-known star maps of the Berlin Academy. These, however, are limited to 15° on each side of the equator, and, therefore, do not include the whole of the region about the ecliptic, which it is so desirable to examine;

neither do they contain stars smaller than between the ninth and tenth magnitudes.

Mr. Bishop, therefore, very soon determined to intrust to Mr. Hind the formation of a series of ecliptic charts, which should contain all stars down to the eleventh magnitude, which were situated within 3° on each side of the ecliptic. Mr. Hind has already begun to reap the fruits of these labours, the planet *Fortuna* having been detected in the course of preparing one of the charts, while *Calliope* and *Thalia* were found by the comparison of two of the completed charts with the heavens.

Eight of these valuable charts have now been published, and I understand that most of the remaining ones are considerably advanced. Other astronomers, particularly Mr. Cooper of Markree, are engaged in the preparation of charts on a similar plan, and the path of future discoverers cannot fail to be singularly facilitated by their means.

The existence of such a numerous group of small planets in the same part of our system has naturally given rise to much speculation respecting their origin and mutual relations. When, instead of the single planet which was expected to fill up the gap between the orbits of *Mars* and *Jupiter*, *Ceres* and *Pallas* were found at very nearly the same mean distance from the sun, Olbers threw out the conjecture that they were fragments of a larger planet which had been rent asunder by some internal convulsion, and that many more such fragments probably existed. If this were the case, he reasoned, they would all, after longer or shorter periods, again pass through the point where the explosion took place, and though the perturbations which they would suffer, would, in the course of time, prevent them from continuing to pass exactly through the same point, yet it might be expected that they would not stray far from it, and that, therefore, the remaining fragments might be found by carefully watching the parts of the heavens corresponding to the two points in which the orbits of *Ceres* and *Pallas* approached towards intersecting.

Although the finding of *Juno* and *Vesta* appeared to give some countenance to this hypothesis, later discoveries have deprived it of much of its plausibility. Several of the orbits are everywhere far distant from each other, and where the contrary is the case, the points of nearest approach occur in various parts of the heavens. Probably one reason why Olbers did not discover more of these bodies, though he continued his examination for many years after detecting *Vesta*, was, that he was induced by his theory to confine the search within too narrow limits.

Several astronomers have endeavoured to find some general relations between the orbits of this group, similar to that imagined by Olbers; but it appears to me that they have only succeeded in showing a kind of general resemblance, indicating rather that similar causes have operated in determining the orbits of these bodies than that they were originally identical.

If we allow ourselves to speculate on the formation of our

planetary system, and adopt the nebular theory, it seems at least as easy to imagine that the nebulous matter, circulating in any particular region about the sun, would, in cooling, collect into many small masses, as that it would all coalesce into one.

Although, as has been stated, there is no single point through which all the orbits nearly pass, yet many of them, taken two and two, approach very closely to each other. In the case of *Astræa* and *Hygeia*, in particular, the shortest distance between the two orbits is less than $\frac{1}{150}$th part of the earth's mean distance from the sun; so that, as M. D'Arrest remarks, the time of their actual intersection cannot be very distant from the present.

One of the most curious circumstances connected with this group is, that there are several cases in which the mean distances are nearly identical with each other. Thus the mean distances of *Ceres* and *Pallas* are so nearly equal, that their order of magnitude is sometimes changed by perturbation. The same remark applies to *Iris* and *Metis*, and also to the three planets, *Astræa*, *Egeria*, and *Irene*.

It should be noticed that this identity of mean distance would not be at all explained by supposing the planets in which it occurs to have been originally one.

There are also some remarkable cases in which the mean motions are nearly commensurable. Thus the mean motions of *Juno* and *Vesta* are very nearly in the ratio of 5 to 6, while those of *Juno* and *Flora* are as 3 to 4, and consequently those of *Vesta* and *Flora* as 9 to 10.*

The extreme smallness of the apparent diameters of these bodies makes it very difficult to determine their real diameters by direct measurement. According to Sir W. Herschel's observations, the diameters of *Ceres* and *Pallas* would not be far from 140 English miles, while Schröter's observations would make them much larger. Stampfer has attempted to determine their diameter by means of their apparent brightness, supposing the reflective power of their surfaces to be the same as that which obtains in the case of *Jupiter*, *Saturn*, *Uranus*, and *Neptune*. This supposition is obviously rather precarious, especially as the reflective power of *Mars* is found to be much less than that of the other planets; but Stampfer's result agrees very closely with the above-mentioned determination of Sir W. Herschel. Several of the more recently-discovered planets appear to be much smaller than these; and it is not improbable that there are many more which, by their excessive minuteness, elude our telescopes altogether. In this point of view, these asteroids would seem to form a connecting link between the larger planets and the aerolites, the cosmical nature of which appears to be pretty well established.

To the physical astronomer these bodies offer problems of great

* The mean daily sidereal motion of *Juno* is 814″·24; that of *Vesta*, 977″·20; and that of *Flora*, 1086″·08. Also $\frac{6}{5} \times 814{\cdot}24 = 977{\cdot}08$, and $\frac{4}{3} \times 814{\cdot}24 = 1085{\cdot}65$.

interest and difficulty. On account of the large eccentricities and inclinations of some of the orbits, methods of approximation which succeed in determining the perturbations of the older planets, become quite inadequate to deal with these, and, consequently, astronomers have hitherto been compelled to have recourse to the method of mechanical quadratures in order to calculate their motions. But although this method may be employed in all cases, and the use of it becomes much simplified by applying it directly to the differential equations of motion, in the elegant manner which has been recently devised by Mr. Bond and Professor Encke, yet it only enables us to follow the disturbed planet, as it were, step by step, and it is therefore very desirable to have a method by which the course of the planet might be traced through an indefinite number of revolutions, and the results of which might be embodied in tables.

Professor Hansen has attacked this very difficult problem with his characteristic originality and skill, and Sir J. Lubbock has also treated the same subject very ably in his tracts on the perturbations of the planets. Much, however, remains to be done before the application of the method of quadratures to these cases can be superseded. It will be quite indispensable to take into account the square and higher powers of the disturbing force.

It may be remarked, however, that the eccentricities and inclinations of the orbits of several of these new planets are so moderate, that there will be little difficulty in calculating their perturbations by the ordinary methods.

The disturbances which these bodies suffer from the action of *Jupiter* are so large as to afford an excellent means of determining the mass of that planet. It was thus that Nicolai found that the value of this mass which had been employed by Laplace and Bouvard was considerably too small,—a result which Mr. Airy afterwards confirmed by direct measures of the elongations of the satellites. Considering the great degree of proximity to each other, to which these bodies sometimes attain, it does not seem improbable, notwithstanding their minuteness, that they may occasionally produce a sensible effect on each other's motions, in which case the astronomer would be able to weigh these minute atoms in the same balance which he has already applied to the larger bodies of our system.

In examining the heavens in search of small planets, Mr. Hind has naturally been led to pay great attention to the variable stars, and he has consequently detected a considerable number of these objects among the smaller stars. Two of these I will mention, which are at opposite extremities of the scale, and which seem to imply the operation of totally different causes.

The first is that remarkable new star in *Ophiuchus* which Mr. Hind noticed on the 27th of April, 1848, as being of the 6th magnitude, and occurring in a spot where he was certain no star even of the 9.10th magnitude had been visible three weeks before.

After attaining to the 4.5th magnitude, so as to be conspicuous to the naked eye, it gradually faded away, and at present it is only of the 11th magnitude.

The other star to which I will refer appears to vary in a similar way to *Algol*. Its period, according to Argelander, is about $9^d\ 11^h\frac{1}{2}$, but for 9 days of this time it shines as a star of the 8th magnitude, then suddenly descends to the 10.11th, and as quickly returns again to the 8th.

Variations of this latter kind appear to be most naturally accounted for by the periodical interposition of an opaque body in its revolution about the star, but those of the kind first-mentioned seem to mock all our attempts at explanation.

In recording these discoveries, it is doubly gratifying to recollect that they emanate from an observatory founded and maintained by a private individual out of pure love of the science and zeal for its advancement. Of the judgment which Mr. Bishop has shown in the selection of his observers, and the choice of objects of observation, there can be no better proof than is afforded by the admirable double-star observations of Mr. Dawes and the planetary discoveries of which we have just been speaking. Mr. Bishop may well feel proud in the consciousness that his observatory has been the means of contributing so largely to science, and has thus become known wherever astronomy is cultivated.

Another subject of congratulation is the manner in which Mr. Hind's services to science have been recognised by the Government of the country. It is sometimes asked, whether the progress of science is best promoted by private or by public means; but the truth is, that there is no such opposition between these modes of advancing it as is implied in the form of the question. In a country where the dignity of science, and the benefits which it confers, are properly estimated, both Government and people will harmoniously co-operate in its support, and each will easily find its appropriate sphere of action. Surely few objects can be mentioned more truly national in their character than the encouragement and reward of scientific discoveries, which at the same time reflect honour on the country, and give so powerful an impulse to the intellectual advancement of the people.

The President then delivering the Medal to Mr. Hind, addressed him in the following terms:—

Mr. Hind,—It is with peculiar pleasure that I present you with this Medal, in testimony of our appreciation of your eminent services to astronomy. The whole world will acknowledge how nobly it has been earned, and will join with us in the wish that your health may long be spared, and that thus you may be able to make many more additions to our knowledge in that field of science to which you have devoted yourself with so much energy and success.

The Meeting then proceeded to the election of the Officers and Council for the ensuing year, when the following Fellows were elected :—

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ERRATUM

In the Notice for January.

Page 68, line 14 from top, *for* $\frac{n''}{n'}\frac{R''.\Delta''.\sin Q''}{R'.\Delta'.\sin Q'}$, *read* $\frac{n''}{n}\frac{R''.\Delta''.\sin Q''}{R'.\Delta'.\sin Q'}$

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